Appendix C

Correspondence Regarding Naval Reactors Facility Radioactive Waste Sent to the Subsurface Disposal Area

Appendix C
CONTENTS

7. NR:IBO-04/122—REVIEW OF ATTACHMENTS TO DOE MEMORANDUM DATED JULY 14, 2004

Department of Energy

Pittsburgh Naval Reactors Office
Idaho Branch Office
P.O. Box 2469
Idaho Falls, Idaho 83403-2469

NR:IBO-04/122

August 13, 2004

J. N. Perry
Waste Area Group Seven
Idaho Operations Office, USDOE

SUBJECT: REVIEW OF ATTACHMENTS TO DOE MEMORANDUM DATED JULY 14, 2004; CONCURRENCE WITH COMMENTS

Reference: a) DOE Memorandum EM-ER-04-152 dated July 14, 2004, Request for Support

NE-ID Request: Reference (a) requested concurrence on Attachments 1 and 2 of the memorandum and to provide a status and anticipated delivery date for the Radioactive Waste Management Complex (RWMC) inventory summary report.

NR/IBO Discussion: The methodology outlined in Attachment 1 will result in the same overall curie content totals for the NRF waste streams as IBO has previously provided. The attachment to this letter provides comments for use with this methodology that include a suggested more accurate method of assigning curie contents for individual shipments in some waste streams, categorization of several waste shipments, and correction of errors that have been identified in the curie totals previously provided by IBO.

Attachment 2 provides a corrosion release rate for activated metal and justifies using a stainless steel release rate for zirconium. As identified in Attachment 2, the stainless steel release rate is higher than that previously recommended by IBO for zirconium. However, the release rate of 8.75E-6 in/yr appears acceptable for the NRF core structural material and zirconium chip waste streams.

The NRF inventory summary report is currently being finalized. The estimated completion date for the inventory summary report is September 30, 2004. NE-ID will be kept informed if this date is changed because of other program work efforts or to support other additional requests for information related to the accelerated remediation efforts of RWMC. Please inform NR-IBO of any schedule changes associated with the extended deadline for OU 7-13/14.

NR/IBO Action: NR/IBO concurs with reference (a) attachments 1 and 2 subject to the attached comments/corrections.

Please give me a call at 533-5294, if you have any questions.

W. R. Dixon
Naval Reactors Idaho Branch Office

Attachment:
As stated

8. NR:IBO-04/045—SUBSURFACE DISPOSAL AREA

Department of Energy
Pittsburgh Naval Reactors Office
Idaho Branch Office
P.O. Box 2469
Idaho Falls, Idaho 83403-2469

NR:IBO-04/045

March 24, 2004

J. G. Snook, Waste Area Group 7
Idaho Operations Office, NE-ID

SUBJECT: SUBSURFACE DISPOSAL AREA INVENTORY

Reference: NE-ID Memorandum EM-ER-04-053, Subsurface Disposal Area (SDA) Inventory, dated March 11, 2004

Attached is the information requested in the reference Memorandum. The Attachment includes: 1. Best Estimates of Specific Radionuclides of Concern Associated with NRF Waste Streams 2. Upper Bound Estimates of Specific Radionuclides of Concern Associated with NRF Waste Streams, and 3. A brief explanation of the estimates provided.

Pending receipt of the final NR/IBO waste stream inventory report, NE-ID may utilize the information transmitted in this letter, as well as NR:IBO-03/070 dated June 11, 2003, and NR:IBO-03/100 dated September 2, 2003, in the preparation of the draft Remedial Investigation/Baseline Risk Assessment and Feasibility Study reports for Waste Area Group 7. Citations of preliminary NR/IBO documents will need to be replaced with reference to the NR/IBO report when it becomes final.

As previously agreed, I look forward to meeting with you and your support team prior to the next model runs. Please contact me at 208-533-5294 if you have any questions.

Wendy Dixon
Naval Reactors Idaho Branch Office

Attachment:
As stated

cc: K. E. Hain, NE-ID

ATTACHMENT TO NR:IBO-04/045

Updated RWMC Inventory Summary Information

Summary of Specific Radionuclides of Concerns Associated with NRF Waste Streams Best Estimate

Waste Stream	C-14 (in Curies)	Tc-99 (in Curies)	I-129 (in Curies)	Cs-137 (in Curies)	Sr-90 (in Curies)
Shippingport Fuel (Solid) (1960-68)	2.84E-02	1.49E+01	3.90E-03	1.06E+04	6.24E+03
Shippingport Fuel (Dissolved) (1960-68)	7.49E-04	3.93E-01	1.03E-04	2.80E+02	1.65E+02
Miscellaneous Enriched Fuel (Solid) (1953-71)	2.36E-07	2.85E-02	4.94E-05	2.07E+02	2.06E+02
Miscellaneous Enriched Fuel (Dissolved) (1953-71)	1.51E-07	1.83E-02	3.16E-05	1.33E+02	1.32E+02
Miscellaneous Natural Fuel (Solid) (1953-71)	6.60E-04	3.46E-02	9.06E-05	2.46E+02	1.45E+02
Core Structural (1953-1997)	4.9E+01	2.6E-02	4.9E-05	9.1E+00	4.8E+00
Zirconium Chips (1953-75)	3.28E+00	9.02E-05	1.73E-07	4.49E-01	2.72E-01
Liquid/APAC/ Oil (1953-71)	4.05E+00	5.05E-03	2.03E-05	2.03E-01	2.03E-01
Sludge/Resin (1953-1971)	1.65E+01	2.56E-02	1.01E-04	1.02E+00	1.02E+00
TOTAL	**7.28E+01**	**1.54E+01**	**4.35E-03**	**1.15E+04**	**6.89E+03**

Summary of Specific Radionuclides of Concerns Associated with NRF Waste Streams Best Estimate (cont.)

Waste Stream	U-233 (in Curies)	U-234 (in Curies)	U-235 (in Curies)	U-236 (in Curies)	U-238 (in Curies)
Shippingport Fuel (Solid) (1960-68)	1.44E-06	6.95E-02	1.47E-03	1.00E-02	7.97E-02
Shippingport Fuel (Dissolved) (1960-68)	3.80E-08	1.53E-03	2.49E-05	2.65E-04	1.81E-03
Miscellaneous Enriched Fuel (Solid) (1953-71)	4.27E-07	7.01E-03	8.60E-05	8.78E-04	3.75E-07
Miscellaneous Enriched Fuel (Dissolved) (1953-71)	2.73E-07	4.49E-03	5.50E-05	5.62E-04	2.40E-07
Miscellaneous Natural Fuel (Solid) (1953-71)	3.35E-08	1.35E-03	2.20E-05	2.33E-04	1.59E-03
Core Structural (1953-1997)	--	1.4E-04	4.0E-06	1.3E-05	1.5E-04
Zirconium Chips (1953-75)	8.79E-05	7.87E-06	2.00E-07	6.08E-07	7.07-06
Liquid/APAC/Oil (1953-71)	1.37E-06	1.52E-06	1.07E-10	5.60E-09	2.49E-08
Sludge/Resin (1953-1971)	6.90E-06	7.70E-06	5.35E-10	2.81E-08	1.25E-07
TOTAL	**9.84E-05**	**8.40E-02**	**1.66E-03**	**1.20E-02**	**8.33E-02**

Summary of Specific Radionuclides of Concerns Associated with NRF Waste Streams Best Estimate (cont.)

Waste Stream	Np-237 (in Curies)	Pu-238 (in Curies)	Pu-239 (in Curies)	Pu-240 (in Curies)	Pu-241 (in Curies)	Am-241 (in Curies)
Shippingport Fuel (Solid) (1960-68)	2.66E-03	1.18E+01	4.43E+01	3.86E+01	3.03E+03	1.08E+1
Shippingport Fuel (Dissolved) (1960-68)	7.03E-05	3.12E-01	1.17E+00	1.02E+00	8.01E+01	2.85E-01
Miscellaneous Enriched Fuel (Solid) (1953-71)	9.70E-04	3.75E+00	7.74E-03	2.23E-03	1.14E+00	2.38E-03
Miscellaneous Enriched Fuel (Dissolved) (1953-71)	6.20E-04	2.40E+00	4.96E-03	1.42E-03	7.30E-01	1.52E-03
Miscellaneous Natural Fuel (Solid) (1953-71)	6.19E-05	2.75E-01	1.03E+00	8.98E-01	7.05E+01	2.51E-01
Core Structural (1953-1997)	--	8.9E-02	2.1E-01	1.3E-01	1.1E+01	1.4E-01
Zirconium Chips (1953-75)	1.16E-06	2.37E-03	1.35E-02	4.72E-03	3.13E-01	1.78E-03
Liquid/APAC/Oil (1953-71)	1.52E-08	1.27E-03	2.03E-04	1.27E-04	5.05E-02	1.78E-03
Sludge/Resin (1953-1971)	7.65E-08	6.40E-03	1.02E-03	6.40-04	2.55E-01	8.95E-03
TOTAL	**4.38E-03**	**1.86E+01**	**4.67E+01**	**4.07E+01**	**3.19E+03**	**1.15E+01**

Summary of Specific Radionuclides of Concerns Associated with NRF Waste Streams Best Estimate (cont.)

Waste Stream	Co-60 (in Curies)	Ni-63 (in Curies)	Ni-59 (in Curies)	Nb-94 (in Curies)	Cl-36 (in Curies)	H-3 (in Curies)
Shippingport Fuel (Solid) (1960-68)	--	--	--	1.37E-05	--	4.62E+01
Shippingport Fuel (Dissolved) (1960-68)	--	--	--	3.62E-07	--	1.22E+00
Miscellaneous Enriched Fuel (Solid) (1953-71)	--	--	--	8.59E-8	--	8.17E-01
Miscellaneous Enriched Fuel (Dissolved) (1953-71)	--	--	--	5.50E-08	--	5.23E-01
Miscellaneous Natural Fuel (Solid) (1953-71)	--	--	--	3.19E-07	--	1.07E+00
Core Structural (1953-1997)	6.1E+05	1.7E+5	1.5E+03	6.5E+00	2.03E-01	1.4E+02
Zirconium Chips (1953-75)	--	4.97E+00	3.93E-02	2.74E-03	4.95E-03	6.70E+00
Liquid/APAC/Oil (1953-71)	5.05E+02	1.52E+02	1.52E+00	1.02E-01	--	--
Sludge/Resin (1953-1971)	2.54E+03	7.65E+02	7.65E+00	5.10E-01	--	--
TOTAL	**6.13E+05**	**1.71E+05**	**1.51E+03**	**7.11E+00**	**2.08E-01**	**1.97E+02**

Summary of Specific Radionuclides of Concerns Associated with NRF Waste Streams Upper Bound Estimate

Waste Stream	C-14 (in Curies)	Tc-99 (in Curies)	I-129 (in Curies)	Cs-137 (in Curies)	Sr-90 (in Curies)
Shippingport Fuel (Solid) (1960-68)	4.26E-02	2.24E+01	5.85E-03	1.59E+04	9.36E+03
Shippingport Fuel (Dissolved) (1960-68)	1.12E-03	5.90E-01	1.55E-04	4.20E+02	2.48E+02
Miscellaneous Enriched Fuel (Solid) (1953-71)	4.25E-07	5.13E-02	8.89E-05	3.73E+02	3.71E+02
Miscellaneous Enriched Fuel (Dissolved) (1953-71)	2.72E-07	3.29E-02	5.69E-05	2.39E+02	2.38E+02
Miscellaneous Natural Fuel (Solid) (1953-71)	9.90E-04	5.19E-02	1.36E-04	3.69E+02	2.18E+02
Core Structural (1953-1997)	9.8E+01	5.2E-02	9.7E-05	1.8E+01	9.6E+00
Zirconium Chips (1953-75)	7.38E+00	2.03E-04	3.89E-07	1.01E+00	6.12E-01
Liquid/APAC/Oil (1953-71)	8.10E+00	1.01E-02	4.06E-05	4.05E-01	4.05E-01
Sludge/Resin (1953-1971)	3.29E+01	5.11E-02	2.01E-04	2.04E+00	2.04E+00
TOTAL	**1.46E+02**	**2.32E+01**	**6.63E-03**	**1.73E+04**	**1.04E+04**

Summary of Specific Radionuclides of Concerns Associated with NRF Waste Streams Upper Bound Estimate (cont.)

Waste Stream	U-233 (in Curies)	U-234 (in Curies)	U-235 (in Curies)	U-236 (in Curies)	U-238 (in Curies)
Shippingport Fuel (Solid) (1960-68)	1.44E-06	6.95E-02	1.47E-03	1.00E-02	7.97E-02
Shippingport Fuel (Dissolved) (1960-68)	3.80E-08	1.53E-03	2.49E-05	2.65E-04	1.81E-03
Miscellaneous Enriched Fuel (Solid) (1953-71)	5.12E-07	8.41E-03	1.03E-04	1.05E-03	4.50E-07
Miscellaneous Enriched Fuel (Dissolved) (1953-71)	3.28E-07	5.39E-03	6.60E-05	6.74E-04	2.88E-07
Miscellaneous Natural Fuel (Solid) (1953-71)	3.35E-08	1.35E-03	2.20E-05	2.33E-04	1.59E-03
Core Structural (1953-1997)	--	2.8E-04	8.0E-06	2.6E-05	3.0E-04
Zirconium Chips (1953-75)	1.32E-04	1.18E-05	3.00E-07	9.12E-07	1.06-05
Liquid/APAC/Oil (1953-71)	2.74E-06	3.04E-06	2.13E-10	1.12E-08	4.97E-08
Sludge/Resin (1953-1971)	1.38E-05	1.54E-05	1.07E-09	5.62E-08	2.50E-07
TOTAL	**1.51E-04**	**8.65E-02**	**1.69E-03**	**1.22E-02**	**8.34E-02**

Summary of Specific Radionuclides of Concerns Associated with NRF Waste Streams Upper Bound Estimate (cont.)

Waste Stream	Np-237 (in Curies)	Pu-238 (in Curies)	Pu-239 (in Curies)	Pu-240 (in Curies)	Pu-241 (in Curies)	Am-241 (in Curies)
Shippingport Fuel (Solid) (1960-68)	3.99E-03	1.77E+01	6.65E+01	5.79E+01	4.55E+03	1.62E+1
Shippingport Fuel (Dissolved) (1960-68)	1.05E-04	4.67E-01	1.75E+00	1.53E+00	1.20E+02	4.27E-01
Miscellaneous Enriched Fuel (Solid) (1953-71)	1.75E-03	6.75E+00	1.39E-02	4.01E-03	2.05E+00	4.28E-03
Miscellaneous Enriched Fuel (Dissolved) (1953-71)	1.12E-03	4.32E+00	8.93E-03	2.56E-03	1.31E+00	2.74E-03
Miscellaneous Natural Fuel (Solid) (1953-71)	9.27E-05	4.13E-01	1.54E+00	1.35E+00	1.06E+02	3.76E-01
Core Structural (1953-1997)	--	1.8E-01	4.2E-01	2.6E-01	2.2E+01	2.8E-01
Zirconium Chips (1953-75)	2.61E-06	5.33E-03	3.04E-02	1.06E-02	7.04E-01	4.01E-03
Liquid/APAC/Oil (1953-71)	3.04E-08	2.53E-03	4.06E-04	2.53E-04	1.01E-01	3.55E-03
Sludge/Resin (1953-1971)	1.53E-07	1.28E-02	2.04E-03	1.28E-03	5.10E-01	1.79E-02
TOTAL	**7.06E-03**	**2.98E+01**	**7.03E+01**	**6.11E+01**	**4.80E+03**	**1.73E+01**

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Summary of Specific Radionuclides of Concerns Associated with NRF Waste Streams Upper Bound Estimate (cont.)

Waste Stream	Co-60 (in Curies)	Ni-63 (in Curies)	Ni-59 (in Curies)	Nb-94 (in Curies)	Cl-36 (in Curies)	H-3 (in Curies)
Shippingport Fuel (Solid) (1960-68)	--	--	--	2.06E-05	--	6.93E+01
Shippingport Fuel (Dissolved) (1960-68)	--	--	--	5.43E-07	--	1.83E+00
Miscellaneous Enriched Fuel (Solid) (1953-71)	--	--	--	1.55E-7	--	1.47E+00
Miscellaneous Enriched Fuel (Dissolved) (1953-71)	--	--	--	9.90E-08	--	9.41E-01
Miscellaneous Natural Fuel (Solid) (1953-71)	--	--	--	4.79E-07	--	1.61E+00
Core Structural (1953-1997)	1.2E+06	3.4E+5	2.9E+03	1.3E+01	4.05E-01	2.7E+02
Zirconium Chips (1953-75)	--	1.12E+01	8.84E-02	6.17E-03	1.11E-02	1.51E+01
Liquid/APAC/Oil (1953-71)	1.01E+03	3.04E+02	3.04E+00	2.03E-01	--	--
Sludge/Resin (1953-1971)	5.08E+03	1.53E+03	1.53E+01	1.02E+00	--	--
TOTAL	**1.21E+6**	**3.42E+05**	**2.92E+03**	**1.42E+01**	**4.16E-01**	**3.60E+02**

The above summary tables were derived using the same information and uncertainty estimates as discussed in letter NR:IBO-03/100 dated September 2, 2003 except as discussed below.

The Shippingport fuel material curie estimates have been revised based on additional information that was recently found. In the preliminary Shippingport Fuel Review forwarded by NR:IBO-03/070 dated June 11, 2003, the best estimate was based on the fuel material having the same average fuel depletion as the PWR Core 1 blanket fuel average. Since that report, records have been found indicating that the small fraction of the blanket fuel that was disposed of at RWMC came from locations that were more irradiated than average.

Final calculations of the curie content of this fuel material are not yet complete, but for the purposes of this summary, the Shippingport fuel material inventory has been revised as follows. For fission product radionuclides, the best estimate curie content was increased by 50 percent. The upper bound estimate was another 50 percent greater than the best estimate. For transuranic nuclides, the preliminary review noted that the ORIGEN-S calculations gave plutonium concentrations approximately three times higher than actual chemical fuel assays conducted in the 1960s. These values were presented as upper bound estimates. In this summary table, the best estimate transuranic values were reduced by a factor of three to account for the ORIGEN-S overcalculation and then increased by 50 percent to account for the additional irradiation for the disposed of fuel material. Upper bound transuranic inventories were another 50 percent greater than the best estimate. For uranium isotopes, the curie content is the same for the best estimate and the upper bound estimate since there is little uncertainty in the amount of uranium. Also, the additional irradiation would not have greatly affected the uranium curies, so the uranium curies were not modified to account for the additional irradiation.

Uranium isotope curies for the unirradiated natural uranium fuel disposed of at RWMC were added to the Shippingport Solid fuel category. Also, the small piece of non-Shippingport natural uranium fuel was again scaled to the revised Shippingport fuel curie estimates.

For the core structural waste stream, NR:IBO-03/100 referenced NR:IBO-98/034 letter dated February 27, 1998, as the source for the total curie amounts for technetium-99, iodine-129, and carbon-14. With the current request for additional radionuclides, this 1998 document was reexamined. Total core structural estimates from the same evaluation were available for nickel-59, nickel-63, and niobium-94. For Cs-137, Sr-90, U isotopes and transuranic isotopes, the values were obtained by taking the ratios of these nuclides to Nb-94 in a more recent evaluation of core structural waste and then using the previously

reported Nb-94 total to obtain the other nuclides. For Co-60, this scaling method would have produced an estimate of 6.2E+05 curies. Since previous NRF and IBO letters had estimated the Co-60 total to be 1.2E+06 curies, this higher value was used for Co-60. All of these values are considered upper bound estimates based on the previously reported assay of three actual pieces of structural waste which demonstrated substantial overestimation in the activation calculations. For the best estimate, the above tables use 50 percent of the upper bound estimates.

The curies associated with the Liquid/APAC/Oil and Sludge/Resin waste streams were revised. This was based on an additional review that was performed on the several thousand disposal records. The changes fall within the uncertainty discussed in NR:IBO-03/100 and do not significantly change the curie totals of the primary radionuclides of concern.

9. NR:IBO-03/070—PRELIMINARY SHIPPINGPORT FUEL REVIEW

THE CONTENTS OF THIS DOCUMENT ARE THE HIGHEST QUALITY AVAILABLE

INITIAL gj **DATE** 7/22/03

Department of Energy
Pittsburgh Naval Reactors Office
Idaho Branch Office
P.O. Box 2469
Idaho Falls, Idaho 83403-2469

NR:IBO-03/070

June 11, 2003

E. D. Sellers, Manager
USDOE, Idaho Operations Office
1 Energy Drive
Idaho Falls, ID 83401-1203

SUBJECT: PRELIMINARY SHIPPINGPORT FUEL REVIEW; FORWARDING OF

Background: In memorandum EM-ER-02-213 dated December 19, 2002, the DOE Idaho Operations Office (DOE-ID) requested Naval Reactors, Idaho Branch Office (NR/IBO) assistance in resolving issues associated with characterizing the waste inventory for the Radioactive Waste Management Complex (RWMC). NR/IBO responded to DOE-ID in letter NR:IBO-03/015 dated February 4, 2003.

One area of particular interest in the DOE-ID request was determining the amount and curie content of irradiated fuel from the Shippingport Pressurized Water Reactor (PWR) that was disposed of at RWMC. DOE-ID requested the following information regarding the Shippingport fuel:

1) A complete review of shipping records and documentation of findings.
2) An assessment of the initial Shippingport fuel mass and an accounting of its ultimate fate.
3) A review of the Shippingport seed fuel.

Discussion: The Naval Reactors Facility (NRF) disposed of a small amount of radioactive waste containing Shippingport PWR Core 1 irradiated fuel at the RWMC in the 1960's when there were no limitations for curie content or transuranic radionuclides in radioactive waste. This letter forwards a preliminary review of the amount of Shippingport fuel disposed of at RWMC. The review includes a detailed evaluation of disposal records as well as a mass balance of both seed and blanket fuel from Shippingport PWR Core 1.

The review concludes that approximately 214 Kg of irradiated natural uranium associated with the Shippingport plant were disposed at the RWMC. Assuming the uranium could be collected from the rest of the waste, the volume would be less than that of a 5 gallon waste paper basket. While this review is provided in

preliminary form, the search for information on Shippingport fuel is essentially complete. The PWR Core 1 seed and blanket fuel received at NRF have been accounted for within the accuracy of record-keeping systems maintained at the time. No significant changes in Shippingport PWR Core 1 information are expected as the remainder of the overall review requested by your memorandum is completed.

NR/IBO requests the opportunity to review in advance any use of the Shippingport preliminary review in correspondence or environmental analysis to ensure that the information and data contained in this review is accurately transmitted.

Action: The NR/IBO preliminary review of radioactive waste containing Shippingport irradiated fuel sent to the RWMC is attached. As requested by your memorandum, additional reports dealing with characterizing the radioactive waste inventory sent from NRF to RWMC will be forwarded to you as they are completed. If you have any questions or need additional information, please contact me at 533-5317.

S. L. Dunn
Naval Reactors Idaho Branch Office

cc: J.G Snook, DOE-ID

Attachment:
Evaluation of Receipt and Disposition of Shippingport Fuel

Evaluation of Receipt and Disposition of Shippingport Fuel

Background on the Expended Core Facility and the Shippingport Pressurized Water Reactor

The Expended Core Facility (ECF), which is located at the Naval Reactors Facility (NRF) on the Idaho National Engineering and Environmental Laboratory (INEEL), has examined and tested fuel from nuclear-powered warships and the Shippingport Atomic Power Station. In addition, ECF has examined small specimens of irradiated fuel that were placed in a test reactor, such as the Advanced Test Reactor. The information from detailed study of this fuel has enabled tremendous improvements to U.S. naval and commercial reactor designs. One result is that the endurance of naval nuclear propulsion plants has been increased from two years for the first core in USS NAUTILUS (SSN 571) to the entire 30+ year lifetime of the submarines under construction today. Most importantly, this research has dramatically improved the warfighting capabilities of America's nuclear-powered warships.

The Shippingport Atomic Power Station was the Nation's first commercial nuclear power reactor. Initial operation was in December 1957. Shippingport was a pressurized water reactor. The first two reactor cores were "seed and blanket" reactor cores. The seed modules had highly enriched uranium, and the blanket modules had natural uranium. The first core (PWR-1) had three partial refuelings where the expended seed fuel was removed and replaced with new seed fuel. Selected blanket fuel also was removed and replaced during the seed refuelings. The final defueling of PWR-1 included the removal of all seed and blanket fuel. The second core (PWR-2) included one refueling, where the seed fuel was removed and replaced. The defueling included the removal of all seed and blanket fuel in preparation for the light water breeder reactor. (reference a)

The seed fuel associated with PWR-1 was referred to as Seed 1, Seed 2, Seed 3, and Seed 4, which correlates with the initial seed loading and the replacement seed fuel at each partial refueling. Figure 1 in Attachment 1 shows the arrangement of the PWR-1 core. There were 32 seed assemblies. Each seed assembly included four subassemblies (128 total) and each subassembly contained 15 fuel elements (1920 total). Figure 2 in Attachment 1 shows a cross section of a seed subassembly. The as-built U-235 loading for Seed 1 was 75 kilograms (Kg) of U-235 while Seeds 2 through 4 had 90 Kg of U-235. Operations with Seed 1 occurred between 1957 and 1959; Seed 2, between 1960 and 1961; Seed 3, between 1961 and 1962; and Seed 4, between 1963 and 1964. (reference b)

In addition to the seed fuel, two test assemblies containing high enriched uranium were placed into PWR-1. These test assemblies, known as Special Oxide Assembly Prototype (SOAP) I and II, replaced blanket fuel assemblies. SOAP-I was placed in the core during the partial refueling for replacement of Seed 2 with Seed 3. SOAP-II was placed in the core during the partial refueling for replacement of Seed 3 with Seed 4. Both SOAP assemblies were removed during the final defueling of PWR-1. (reference b)

The PWR-1 blanket fuel was made of natural uranium in the form of natural uranium dioxide pellets clad with zircaloy tubes. Figure 3 in Attachment 1 shows the arrangement of a PWR-1 blanket assembly. Each blanket assembly was made from seven stacked fuel bundles. Each fuel bundle was an array of zircaloy tubes with natural uranium oxide pellets in the tubes. PWR-1 had space for 113 blanket assemblies. Each assembly contained seven fuel bundles (total of 791) and each bundle contained 120 fuel rods (total of 94,920). The as-built natural uranium loading for the blanket fuel was approximately 12,850 Kg of natural uranium. (references a,c,d)

During each seed refueling of PWR-1, some blanket fuel assemblies were removed primarily for testing purposes to evaluate the performance of the blanket fuel. Most of the blanket fuel was not removed during the refuelings and remained in PWR-1 through all four seeds. During the Seed 1

replacement with Seed 2, two blanket fuel bundles and one blanket assembly were replaced and sent to ECF at NRF for testing purposes. During the Seed 2 replacement with Seed 3, three blanket assemblies were replaced and sent to NRF. The SOAP-I test assembly replaced one blanket assembly, while the other two blanket subassemblies were removed for testing purposes.

When Seed 3 was replaced with Seed 4, again three blanket assemblies were replaced and sent to NRF. The SOAP-II test assembly replaced one blanket assembly and the Special Assembly of Blanket Rod Elements (SABRE) assembly replaced another. The SABRE assembly was a natural uranium blanket assembly where the fuel rods extended the full height of the core rather than being subdivided into smaller stacked bundles. During the final defueling of PWR-1, all the blanket and seed fuel was removed.

The PWR-2 core was also a seed and blanket core with 20 seed assemblies and 77 blanket assemblies. The core had one refueling where Seed 1 was replaced with Seed 2 fuel. The first seed operated between 1965 and 1969, while the second operated between 1969 and 1974. The as-built U-235 loading of PWR-2 Seed 1 was 336 Kg U-235, and Seed 2 was 390 Kg U-235. The blanket fuel, had an as-built natural uranium loading of 17,100 Kg natural uranium. (references e,f)

One blanket assembly location in PWR-2 was occupied by a Multipurpose Extended Life Blanket Assembly (MELBA). The purpose of the MELBA assembly was to determine the effect of extended irradiation on PWR-1 blanket bundles. Eighteen PWR-1 blanket bundles were retained for use in the MELBA. Nine bundles were inserted in the MELBA assembly and irradiated during PWR-2 Seed 1 operation. Nine bundles were retained as backup bundles. During the PWR-2 partial refueling, the MELBA assembly was removed. Three bundles were replaced with backup bundles, and the MELBA assembly was reinserted for operation with PWR-2 Seed 2. One regular blanket assembly also was removed for examination and replaced during the partial refueling. All seed and blanket fuel was removed from the Shippingport reactor following completion of PWR-2 operation in 1974. (references e,f,g)

Purpose of This Evaluation

Examination of spent fuel at ECF can involve the testing of small pieces that are removed from the fuel. Some pieces may also undergo destructive evaluation, such as chemical dissolution and measurement of the amount of individual radionuclides in those pieces. In some cases, these examinations resulted in waste containing small amounts of irradiated fuel. Prior to 1970, some of these wastes were disposed of at the Radioactive Waste Management Complex (RWMC) at INEEL in accordance with the radioactive waste requirements at that time.

In reference (h), the DOE Idaho Operations Office (DOE-ID) requested Naval Reactors, Idaho Branch Office (NR/IBO) assistance in resolving issues associated with characterizing the waste inventory for the Radioactive Waste Management Complex (RWMC). One area of particular interest in this request was determining the amount and curie content of irradiated fuel from the Shippingport plant which was disposed of at RWMC. DOE-ID requested the following information regarding the Shippingport fuel:

(1) A complete review of shipping records and documentation of findings.
(2) An assessment of the initial Shippingport fuel mass and an accounting of its ultimate fate.
(3) A review of the Shippingport seed fuel.

The purpose of this evaluation is to provide a documentation of the requested information. This includes a summary of the disposition of the Shippingport irradiated fuel and a justification for the adequacy of the estimated quantity of fuel sent to the RWMC. The information provided should be used in any inventory estimates for this specific waste stream.

Receipt of Shippingport Fuel at ECF

All Shippingport PWR-1 and PWR-2 Seed fuel as well as the high enriched uranium SOAP test assemblies were shipped to the Expended Core Facility (ECF) following the various seed refuelings and defuelings. Attachment 2 provides a listing of all PWR-1 seed fuel receipts at ECF.

Only a portion of the blanket fuel assemblies from PWR-1 was sent to ECF for examination. Attachment 3 provides a listing of all PWR-1 blanket fuel receipts at ECF. The 4330 kilograms of uranium in PWR-1 blanket fuel shipped to ECF were about one third of the total 12,850 kilograms of uranium in the PWR-1 blanket. The other two thirds of the blanket fuel were sent directly to Hanford.

All shipments of MELBA and PWR-2 seed and blanket fuel to ECF occurred after the change in burial requirements in 1970. Therefore, there is no concern that any of the PWR-2 fuel in ECF's possession, including the MELBA bundles, was disposed of at RWMC. All PWR-2 fuel that was not sent to INTEC for processing or to another off-site organization for testing and examination remains in storage at ECF. PWR-2 fuel receipts and disposition are not discussed further in this evaluation.

Review of Waste Disposal Records

Previous record reviews by DOE-ID contractor personnel have found several "Waste Disposal and Authorization Forms" originating from ECF that have identified irradiated PWR fuel in the waste contents. A thorough review of NRF waste disposal records was performed to determine whether any additional PWR irradiated fuel shipments to RWMC could be found.

Several sources of information were considered in the review of irradiated PWR-1 fuel that may have been sent to the RWMC. These sources included NRF RWMC shipping manifest disposal records, past letters, and monthly disposal reports. The NRF waste shipping manifests were verified complete by the sequential numbering used during this time period for shipments sent from various facilities at NRF. For example, shipments from ECF in 1960 began with the number 69 (meaning there was 68 previous shipments from ECF prior to 1960) and were sequentially numbered to 934 through the end of 1965. In 1966, the sequential numbering was modified such that the first shipment for the year was E-1 ("E" for ECF, "S" for S1W, etc.) and shipments were sequentially numbered until the beginning of the next year. This numbering system helped verify the completeness of the shipping records. PWR-1 fuel shipments from NRF would have originated from ECF. Beginning in 1970, those wastes defined as transuranic materials were not sent to RWMC for permanent burial.

Attachment 4 provides copies of all of the Waste Disposal and Authorization Forms (waste shipping manifests) to RWMC related to irradiated PWR fuel. No additional irradiated fuel shipments were found during this latest review other than those provided by the DOE-ID contractor. The Waste Disposal and Authorization Forms usually included descriptions, volumes, weight, container type, estimated curies, radiation levels, and various approvals for the waste shipment. All of the Waste Disposal and Authorization Forms manifests include a nuclear material accountability signature (referred to as an "SS" signature on the manifest) that was signed if fuel was part of the shipment. In general, the information provided on the manifests were accurate with the exception of the curie totals and radionuclide content. The listed radioactivity content varied widely for similar shipments, and thus cannot be considered reliable. The mass of nuclear material (i.e., uranium, plutonium, etc.) is likely to be accurate since these were based on fuel accountability requirements and were verified with signatures by those responsible for the nuclear material. Also, the listed masses are consistent with the listed content and do not indicate the same variation and inconsistencies as the curie content.

Attachment 5 lists the known shipments of PWR irradiated fuel to the RWMC and provides an estimate of the fuel disposed at the RWMC based on the NRF shipping disposal manifests. A total of approximately 214 Kg of irradiated uranium is estimated to have been sent to the RWMC. A small fraction of this fuel, 5.48 Kg of uranium, was in a dissolved form absorbed in vermiculite. During

testing and analysis at ECF, small quantities of material were dissolved in nitric and hydrofluoric acid. The remainder of the irradiated fuel was listed as being in individual rods or bundles of rods. While no information is available on the integrity of the cladding in these rods, it is likely that the cladding was intact in cases where complete bundles were disposed of (190 Kg uranium). In cases were individual rods were disposed of or bundles were incomplete or partially disassembled (18 Kg uranium), it would be appropriate to assume that the rod cladding is open to the immediate environment. Figure 4 in Attachment 1 shows the typical configuration of a PWR-1 rod.

As noted above, no additional shipments of irradiated PWR-1 fuel were identified during this review. In fact, the 214 Kg of irradiated uranium listed in Attachment 5 is approximately 16 Kg less than the 230 Kg total listed in the preliminary evaluation forwarded by the Naval Reactors Idaho Branch Office on March 6, 2002 (reference i). The reduction is due to the determination that a 16 Kg shipment documented in a nuclear material inventory reconciliation report for the second half of 1969 and first half of 1970 was actually unirradiated uranium rather than irradiated uranium. Shipments of unirradiated uranium to RWMC will be addressed in a future report.

Material Balance for PWR-1 Seed and Blanket Fuel Received at ECF

As part of this review, a material balance was conducted to compare the amount of PWR-1 fuel that was received at ECF with the amount that was shipped out from ECF or is still in storage at ECF. Separate material balances were performed for the seed fuel and the blanket fuel. One difficulty in performing such material balances was locating the specific fuel transfer records for PWR-1 fuel. Over its long history, ECF has received and transferred large amounts of nuclear fuel in a very large number of transactions. In addition to the Shippingport fuel, these transactions include the much larger amount of naval spent fuel as well as a large number and variety of irradiated fuel test specimens. Fuel transfer records from the 1960's are not computerized, nor are they sorted by type of fuel such as PWR-1. Generally, these records are grouped by the site of origin for receipts and the destination site for transfers. Records of receipt of Shippingport PWR-1 fuel at ECF were relatively easy to locate because they came primarily from the Shippingport site at known times. Transfers of various types of fuel away from ECF went to a large number of places both on INEEL and off-INEEL. Known locations of off-INEEL transfers include the Bettis and Knolls Atomic Power Laboratories, Battelle Columbus Laboratory, Battelle Pacific Northwest Laboratory, other Hanford contractors, Chalk River in Canada, Oak Ridge National Laboratory, and the Savannah River Site. When looking for PWR-1 fuel transfer records, it has been necessary to concentrate the search on destinations where such fuel is known to have been sent and timeframes when such transfers were most likely to have occurred. Thus, it is possible that some records of PWR-1 transfers from ECF may not have been located among the large number of historical records. Such cases, if they exist, would tend to inflate the potential deficit of PWR-1 fuel in these material balances.

Another source of uncertainty in such material balances involves knowing precisely how much uranium was in a particular piece of PWR-1 fuel. While the as-built quantities of uranium in new PWR-1 fuel would be known within manufacturing tolerances, the amount of uranium remaining in irradiated fuel was less well known. One of the chief reasons for examining PWR-1 seed and blanket fuel was to determine the accuracy of calculations of how many fissions occurred in various parts of the core. Thus, the understanding of how much uranium would have been in individual parts of the PWR-1 core would have changed as a result of the examination. It is not clear that the amount of uranium listed for any particular piece would be the same when that piece was transferred from ECF as it was when that piece was shipped to ECF. As a result of these types of potential differences, these material balances should be considered as an indication that there is not a large potential deficit of fuel, and not an exact reconciliation.

All of the PWR-1 seed fuel was shipped to ECF from Shippingport. Attachment 2 provides a detailed listing of each shipment of seed fuel. The high enriched uranium SOAP test assemblies are included in the seed fuel listing. This is summarized below. The "Element" refers to the total uranium mass while "Isotope" refers to U-235.

Summary of PWR-1 Seed Fuel Received at NRF

Seed 1	32 Seed Assemblies Received	55,441 g Element 45,322 g Isotope
Seed 2	32 Seed Assemblies Received	62,256 g Element 49,238 g Isotope
Seed 3	32 Seed Assemblies Received	63,630 g Element 47,440 g Isotope
Seed 4	32 Seed Assemblies Received	64,746 g Element 52,016 g Isotope
SOAP-I		760 g Element 477 g Isotope
SOAP-II		1,011 g Element 914 g Isotope
Total	128 Seed Assemblies Received & SOAP-I/SOAP-II Test Assemblies	247,844 g Element 195,407 g Isotope

Attachment 6 is a listing of the disposition of the PWR-1 seed fuel and SOAP test assemblies. Most of the shipments were to ICPP, which is consistent with the high enriched uranium content of this fuel. Some SOAP fuel remains in storage at ECF today. A summary of Attachment 6 is provided below.

Summary of PWR-1 Seed Fuel for Which Disposition is Known

Seed 1	52,988 g Element 43,304 g Isotope
Seed 2	60,801 g Element 48,087 g Isotope
Seed 3	61,891 g Element 46,143 g Isotope
Seed 4	64,734 g Element 52,015 g Isotope
Combined Seed or Unspecified Seed	4,781 g Element 3,744 g Isotope
SOAP	1,622 g Element 1,191 g Isotope
Total	246,817 g Element 194,484 g Isotope

The amount of seed fuel received slightly exceeds the amount listed in the known disposition table by 1.027 Kg total uranium with 0.923 Kg U-235. None of the records of known shipment of Shippingport fuel to RWMC included PWR-1 seed fuel or high enriched uranium SOAP fuel. As discussed previously, the search for PWR-1 fuel reviewed several thousand transactions and a few individual transactions may have been overlooked during the search. Another possibility is that small pieces of PWR-1 seed fuel were included with other high enriched uranium shipments to ICPP. There are records of shipments of small pieces of high enriched fuel to ICPP for which the specific fuel type is not recorded. As noted above, the amount of uranium in any individual part of fuel may have changed due to different methods of estimating or calculating uranium content. Finally, it is likely that small amounts of PWR-1 seed fuel were destructively analyzed and the material became part of the other ECF radioactive waste streams that would have gone to RWMC. As part of the overall review of NRF waste shipments to RWMC, these other waste streams are being separately evaluated. Due to the relatively small amount of PWR-1 seed fuel with unknown disposition, the lack of any disposal records clearly indicating disposal of PWR-1 seed fuel at RWMC, and the ready availability of a disposition path at ICPP in the 1960s for high enriched uranium fuel, it is concluded that no separate RWMC source term is needed for PWR-1 seed fuel.

A separate material balance was performed for PWR-1 blanket fuel. Attachment 3 lists the receipt of PWR-1 blanket fuel. This is summarized below.

Summary of PWR-1 Blanket (Natural Uranium) Fuel Received at NRF

Total PWR-1 Blanket Fuel Received	4 Fuel Bundles 38 Blanket Assemblies 1 SABRE Assembly
Total (Mass) PWR-1 Blanket Fuel Received	4330 Kg U

Attachment 7 is a listing of the disposition of the PWR-1 blanket fuel. The search for sites where blanket fuel might have been sent was much more difficult than for the PWR-1 seed fuel because ICPP did not process natural uranium fuels and a much larger number of potential destination sites were possible. NRF performed a search of the fuel transaction records and the shipping manifests between 1960 and 1980 to identify any shipments that may contain PWR-1 blanket fuel. Most of the PWR-1 blanket fuel received at ECF was discovered to have been shipped to Hanford. Some blanket fuel remains in storage at ECF. Waste disposal records indicate that 214 Kg of uranium were shipped to RWMC for disposal. A summary of Attachment 7 is provided below.

Summary of PWR-1 Blanket Fuel for Which Disposition is Known

PWR-1 Blanket Fuel at RWMC	214 Kg U
PWR-1 Blanket Fuel Transferred to Other Sites	3811 Kg U
PWR-1 Blanket Fuel in Storage at ECF	304 Kg U
Total Accounted for PWR-1 Blanket Fuel	4329 Kg U

The amount of PWR-1 blanket fuel received exceeds the amount listed in the known disposition table by one Kg. This is a very small fraction of the amount of PWR-1 blanket fuel received at ECF. Minor differences in the quantity of PWR-1 blanket fuel shipped or in storage could be the result of various estimation methods, such as burn up calculations, assay sampling, fuel processing recovery amounts, etc. that could have been used to estimate the remaining fuel. Also, transfer records for natural uranium fuel were often rounded to the nearest kilogram which could account for small differences. Given the fact that the numbering and description of waste disposal records appears to be complete and the amount of potentially unaccounted for blanket fuel is so small, this blanket fuel material balance does not constitute a data gap that would warrant assigning a higher value to the amount of PWR-1 blanket fuel disposed of at RWMC.

Calculation of Curie Content of PWR-1 Blanket Fuel at RWMC

Attachment 8 provides an assessment of the curie content of the PWR-1 blanket fuel sent to the RWMC. Various assumptions were used to provide a best estimate of the curie content of the fuel. Attachment 8 defines assumptions made and the modeling used, and provides the results for radioisotopes of primary concern. The data in Attachment 8 provides isotopic activities per kilogram of uranium for a selected list of isotopes. These data have been used to develop Table 1 which lists isotopic activities associated with the 214 Kg or uranium shipped to the RWMC for disposal. (references c, j, n, o)

Uncertainty

Given that the results of the material balances correlate well with the review of burial records, the 214 Kg of uranium at RWMC is considered accurate. As discussed in Attachment 8, the calculated curie content per kilogram of uranium is considered to be accurate within approximately 50 percent for fission product radionuclides. For plutonium and other actinide radionuclides, the curie content calculation is known to be significantly conservative. The uncertainty range for plutonium and other actinides would be from one third of the listed value up to the listed value.

Summary

NRF reviewed shipping disposal manifests, fuel transaction records, monthly disposal records, etc. to evaluate the waste stream associated with fuel from the Shippingport Atomic Power Station. The review concluded that approximately 214 Kg of irradiated natural uranium associated with the Shippingport plant were disposed at the RWMC. Of the 214 Kg, approximately 5.5 Kg was in dissolved form absorbed in vermiculite. Approximately 190 Kg is likely to have intact cladding while 18 Kg should be considered to be in pellet form with potentially non-intact cladding. The total curie content is shown in Table 1 below at the one and five years of decay which encompasses the timeframe that the Shippingport fuel was sent to the RWMC after shutdown of PWR-1.

Table 1. Isotopic Activities for PWR-1 Irradiated Fuel Sent to RWMC

Isotope	1 Years Decay Total Curies	5 Years Decay Total Curies
Ac-227	3.57E-08	9.57E-08
Am-241	2.22E+01	5.83E+01
Am-243	4.80E-02	4.80E-02
C-14	1.94E-02	1.94E-02
Cm-244	7.17E-01	6.13E-01
Cs-137	7.27E+03	6.60E+03
Eu-152	1.57E+00	1.27E+00
Eu-154	1.75E+02	1.27E+02
H-3	3.16E+01	2.52E+01
I-129	2.67E-03	2.67E-03
Nb-94	9.40E-06	9.40E-06
Np-237	5.47E-03	5.53E-03
Pa-231	4.97E-07	5.80E-07
Pb-210	3.53E-10	1.39E-09
Pu-238	2.43E+01	2.46E+01
Pu-239	9.10E+01	9.10E+01
Pu-240	7.93E+01	7.93E+01
Pu-241	6.23E+03	5.13E+03
Pu-242	5.23E-02	5.23E-02
Ra-226	5.33E-09	1.37E-08
Ra-228	4.50E-13	1.46E-12
Sr-90	4.27E+03	3.87E+03
Tc-99	1.02E+00	1.02E+00
Th-228	7.53E-05	1.86E-04
Th-229	1.29E-09	1.83E-09
Th-230	3.73E-06	5.93E-06
Th-232	2.00E-12	4.03E-12
U-232	1.62E-04	2.44E-04
U-233	1.48E-06	1.57E-06
U-234	5.97E-02	6.00E-02
U-235	9.70E-04	9.70E-04
U-236	1.03E-02	1.03E-02
U-238	7.03E-02	7.03E-02

References

a) WAPD-T-3007, The Shippingport Pressurized Water Reactor and Light Water Breeder Reactor, October 1993

b) WAPD-320, PWR Core 1 Component Examination Program Summary Report, October 1969

c) WAPD-T-1608, Isotopic Composition of PWR Core 1 Blanket Irradiated to 16,000 MWD/Metric Ton U: Theory Vs Experiment, September 1963

d) WAPD-OP(PWR)RD-343, PWR Core 1 Seeds 1-5 Total Residual Seed Fuel Analysis, November 1966

e) WAPD-296, PWR Core 2 Reactor Design Description Report, March 1968

f) WAPD-PWR-TE-206, Shippingport PWR Core 2 Seed 1 Physics Test Results from Mid-life to End-of-Life Test Evaluation, March 1970

g) WAPD-TM-1412 Addendum, Corrosion and Hydriding Performance Evaluation of 3 Zircaloy-2 Clad Fuel Assemblies after Continuous Exposure in PWR Core 1 and 2 at Shippingport, PA, December 1983

h) DOE Memorandum dated December 19, 2002, Review of Draft Report (EM-ER-01-213)

i) NR:IBO-02/032 letter dated March 6, 2002, Follow-on Comments Regarding Naval Reactors Program Radionuclide Inventories at the Subsurface Disposal Area

j) WAPD-TM-265, Isotopic Analysis of Irradiated Natural Uranium Dioxide Fuel Rods from PWR Core 1, February 1962

k) WAPD-TM-637, Depletion Analysis of Shippingport (PWR) Core-1, Seeds 1 and 2, Using the TNTO2 Computer Program, November 1967

l) WAPD-MT(FZCT)-78, Disposal of MELBA Bundles, February 1981

m) WAPD-OP(PWR)RD-608, PWR Core 1 Seeds 1, 2, and 3 Seed Fuel Punching Analysis, April 1968

n) WAPD-PWR-RD-1557, PWR-1 Component Examination Program, May 1963

o) WAPD-T-2004, Residual Fuel Content of Shippingport Core 1 Seed Fuel: Calculation Versus Experiment, June 1967

Attachments

Attachment 1 – Shippingport PWR-1 Figures

Attachment 2 – Shippingport Core 1 Seed Fuel and Soap Assemblies Received at NRF

Attachment 3 – Shippingport Core 1 Blanket Fuel (Natural Uranium) Received at NRF

Attachment 4 – Copies of Waste Shipping Manifests Containing PWR-1 Irradiated Fuel

Attachment 5 – Summary of Shipping Records to RWMC Related to Irradiated Shippingport Fuel

Attachment 6 – Shippingport Core 1 Seed Fuel and Soap Assemblies Transferred to Off-Site Locations or in ECF Storage

Attachment 7 – Shippingport Core 1 Blanket Fuel (Natural Uranium) Transferred to Off-Site Locations (Other than RWMC) or in ECF Storage

Attachment 8 – Curie Content of PWR-1 Blanket Fuel

Attachment 1

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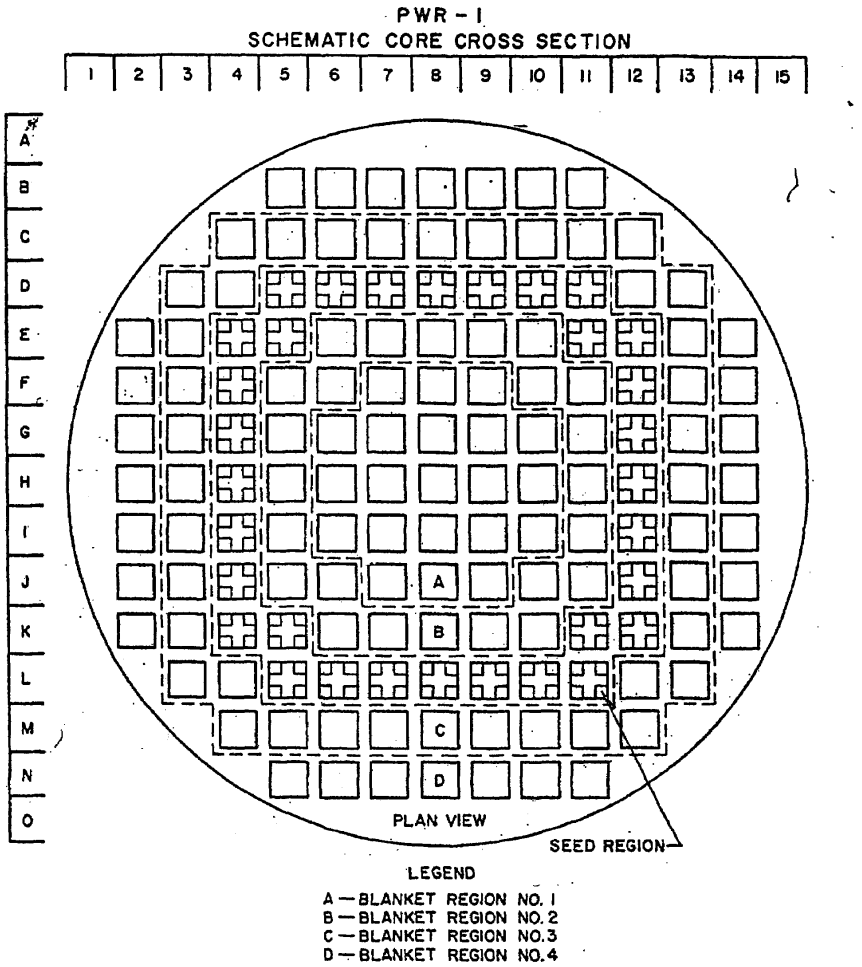


Figure 1. Cross-Section of Shippingport PWR-1 Core

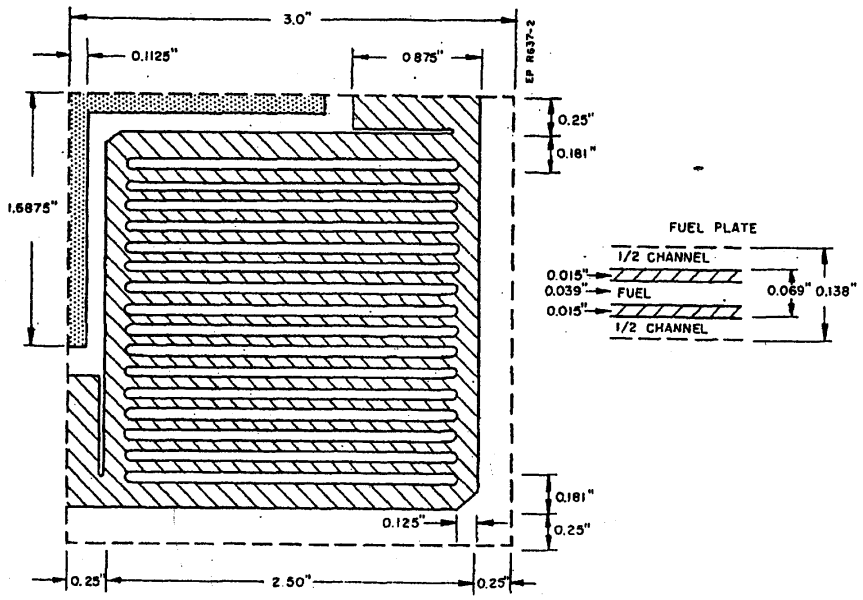


Figure 2. Cross-Section of PWR-1 Seed Subassembly

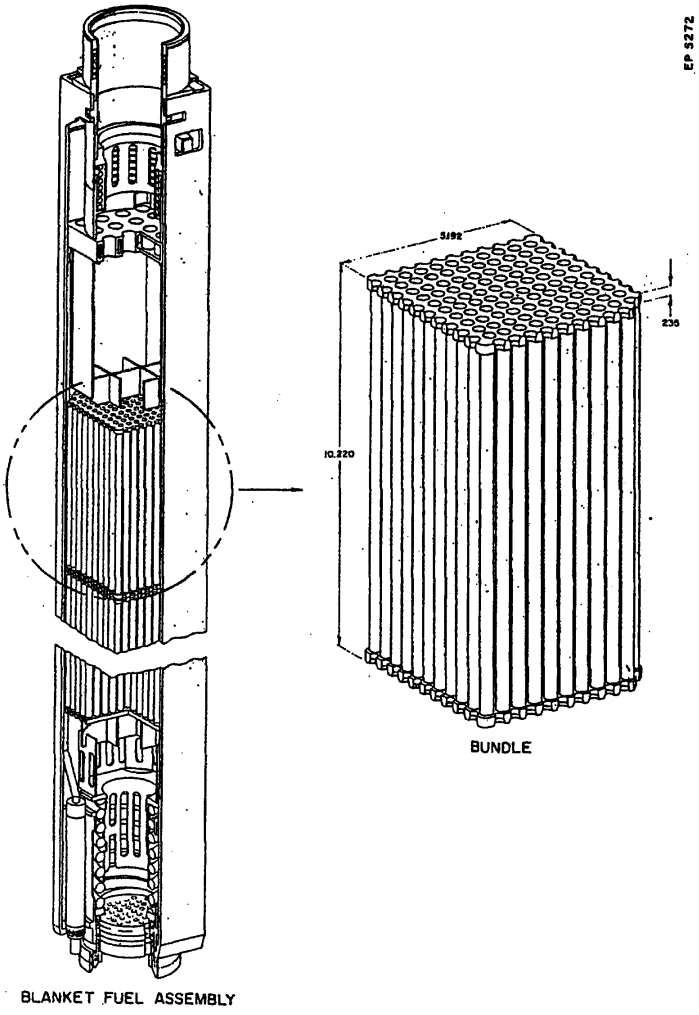
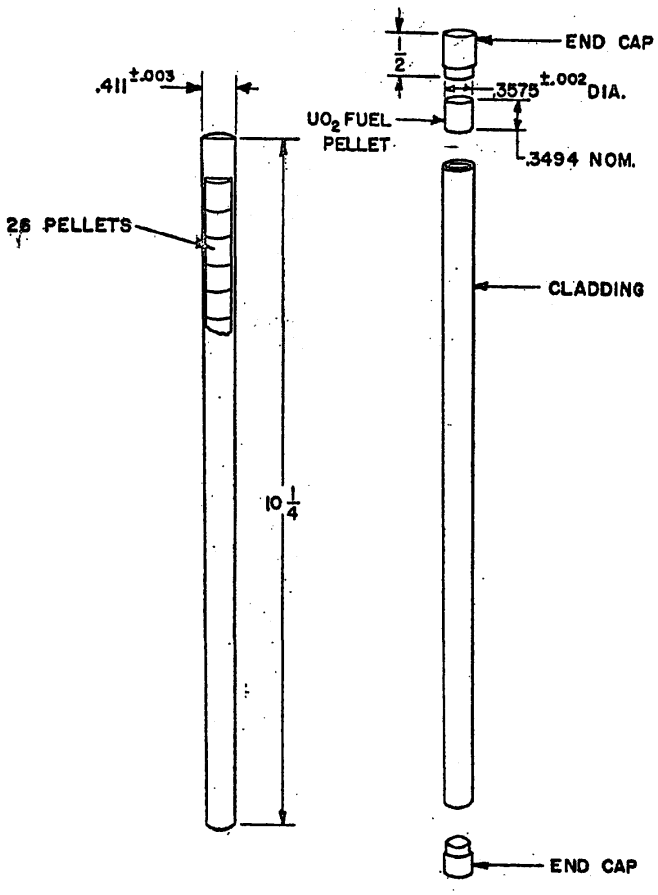


Figure 3. PWR-1 Blanket Assembly



PWR-1 UO_2 FUEL ROD

NOTE: DIMENSIONS ARE IN INCHES

Figure 4. PWR-1 Fuel Rod

Attachment 2

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SHIPPINGPORT CORE 1 SEED FUEL AND SOAP ASSEMBLIES RECEIVED AT NRF

All Shippingport (PWR) seed fuel was received at NRF from the Duquesne Light Company. Core 1 included four refuelings where all seed fuel was replaced. There were 32 assemblies of seed fuel associated with each refueling. Each assembly contained four subassemblies. Each subassembly contained 15 fuel elements. The SOAP-I and SOAP-II were special seed fuel test assemblies. "Element" quantities refer to the total mass of uranium. "Isotope" quantities refer to total mass of Uranium-235. The serialized fuel accountability transfer transactions are referenced.

Date	Fuel Received at NRF	Quantity	Reference
5/5/60	1 Expended Seed assembly from Core I, Seed 1 of the Shippingport Atomic Power Station (SAPS)	1,732 g Element 1,416 g Isotope	DUQ-WEI-4
7/22/60	1 Expended Seed Assembly from Core I, Seed 1 of SAPS.	1,732 g Element 1,416 g Isotope	DUQ-WEI-5
2/20/61	16 Expended Seed Assemblies from Core I, Seed 1 of SAPS.	27,720 g Element 22,661 g Isotope	DUQ-WEI-6
3/31/61	14 Expended Seed Assemblies from Core I, Seed 1 of SAPS.	24,257 g Element 19,829 g Isotope	DUQ-WEI-7
11/16/61	16 Expended Seed Assemblies from Core I, Seed 2 of SAPS.	31,128 g Element 24,619 g Isotope	DUQ-WEI-11
12/15/61	16 Expended Seed Assemblies from Core I, Seed 2 of SAPS.	31,128 g Element 24,619 g Isotope	DUQ-WEI-13
3/13/63	16 Expended Seed Assemblies from Core I, Seed 3 of SAPS.	31,815 g Element 23,720 g Isotope	DUQ-WEI-15
6/6/63	14 Expended Seed Assemblies from Core I, Seed 3 of SAPS.	27,838 g Element 20,755 g Isotope	DUQ-WEI-16
7/25/63	2 Expended Seed Assemblies from Core 1, Seed 3 of SAPS	3,977 g Element 2,965 g Isotope	DUQ-WEI-18
5/25/64	Receipt of PWR-1 SOAP II fuel from Duquesne.	1,011 g Element 914 g Isotope	DUQ-WEI-20
12/23/64	4 Expended Seed Assemblies from Core 1, Seed 4 of SAPS.	8,093 g Element 6,502 g Isotope	PAB-PZB-1
	SOAP-I (Subassembly No. x)	760 g Element 477 g Isotope	
3/8/65	12 Expended Seed Assemblies from Core 1, Seed 4 of SAPS.	24,280 g Element 19,506 g Isotope	PAB-PZB-2
3/26/66	16 Expended Seed Assemblies from Core 1, Seed 4 of SAPS.	32,373 g Element 26,008 g Isotope	PAB-PZB-3

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Summary Core 1 Received at NRF

Seed 1	32 Seed Assemblies Received	55,441 g Element 45,322 g Isotope
Seed 2	32 Seed Assemblies Received	62,256 g Element 49,238 g Isotope
Seed 3	32 Seed Assemblies Received	63,630 g Element 47,440 g Isotope
Seed 4	32 Seed Assemblies Received	64,746 g Element 52,016 g Isotope
SOAP-I		760 g Element 477 g Isotope
SOAP-II		1,011 g Element 914 g Isotope
Total	128 Seed Assemblies Received & SOAP-I/SOAP-II Test Assemblies	247,844 g Element 195,407 g Isotope

Attachment 3

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SHIPPINGPORT CORE 1 BLANKET FUEL (NATURAL URANIUM) RECEIVED AT NRF

Shippingport (PWR) irradiated blanket fuel was primarily received at NRF from the Duquesne Light Company. Core 1 included three refuelings where portions of the blanket fuel were replaced. A final defueling included all the blanket fuel being replaced. There were 113 blanket assemblies contained in Core 1. Each blanket assembly contained seven fuel bundles. Each fuel bundle contained 120 fuel rods. "Element" quantities refer to the total mass of uranium. "Isotope" quantities refer to total mass of Uranium-235. The serialized fuel accountability transfer transactions are referenced.

Date	Fuel Received at NRF	Quantity	Reference
2/4/60	Receipt of one Irradiated Fuel Bundle from Reactor at Shippingport Atomic Power Station (SAPS). Bundle is from Original Blanket Assembly No. 031.	16 Kg Element 0.081 Kg Isotope 37 g Plutonium	DUQ-WEI-1
2/12/60	Receipt of 1 Irradiated Blanket Assembly from Reactor at SAPS.	112 Kg Element 1 Kg Isotope[a] 261 g Plutonium	DUQ-WEI-2
2/15/60	Receipt of 1 Irradiated Fuel Bundle from Reactor at SAPS.	16 Kg Element 0.081 Kg Isotope 37 g Plutonium	DUQ-WEI-3
9/22/61	Receipt of 1 Irradiated Blanket Assembly from Reactor at SAPS.	112 Kg Element 0.372 Kg Isotope 501 g Plutonium	DUQ-WEI-8
10/16/61	Receipt of 1 Irradiated Blanket Assembly from Reactor at SAPS.	112 Kg Element 0.372 Kg Isotope 501 g Plutonium	DUQ-WEI-9
11/24/61	Receipt of 1 Irradiated Blanket Assembly from Reactor at SAPS.	112 Kg Element 1 Kg Isotope[b] 501 g Plutonium	DUQ-WEI-12
1/21/63	Receipt of Irradiated Blanket Assembly from Reactor at SAPS.	111 Kg Element 0.339 Kg Isotope 525 g Plutonium	DUQ-WEI-14
6/6/63	Receipt of 2 Irradiated Blanket Assemblies from Reactor at SAPS.	223 Kg Element 1 Kg Isotope[c] 208 g Plutonium	DUQ-WEI-17
4/3/64	Receipt SABRE Assembly	87 Kg Element 1 Kg Isotope[d] 208 g Plutonium	DUQ-WEI-19
7/21/64	Receipt of two PWR Core 1 fuel bundles from Bettis. (ref. values from DUQ-WEB-16)	31.6 Kg Element 0.08 Kg Isotope 165 g Plutonium	PZA-PZB-1

1

12/23/64	Receipt of 10 irradiated Blanket Fuel Assemblies with 7 original Fuel Bundles and1 irradiated Blanket Fuel Assembly with 6 original Fuel Bundles and 1 unirradiated Fuel Bundle containing Normal Uranium.	1204 Kg Element[e] 3 Kg Isotope[f] 6263g Plutonium	PAB-PZB-1
3/8/65	Receipt of 4 irradiated Blanket Fuel Assemblies containing depleted Uranium and Plutonium.	412 Kg Element 1 Kg Isotope[g] 2143g Plutonium	PAB-PZB-2
6/18/66	Receipt of 16 PWR-1 irradiated Blanket Fuel Assemblies containing Depleted Uranium and Plutonium from Duquesne Light Co.	1,781 Kg Element 6 Kg Isotope 9392g Plutonium	PAB-PZB-4

Notes:

(a) Value was likely rounded up. A more likely quantity is 0.567 Kg (based on 0.081 Kg per fuel bundle and each assembly containing 7 bundles – see 2/4/60 shipment)

(b) Value was likely rounded up. A more likely quantity is 0.372 Kg (see 10/16/61 shipment)

(c) Value was likely rounded up. A more likely quantity is 0.678 Kg (based on 0.339 Kg per fuel bundle - see 1/21/63 shipment)

(d) Value was likely rounded up. If same ratio of "Isotope" to "Element" as 2/60 shipments is used (which is the highest such ratio), the quantity would be 0.44 Kg.

(e) Total does not include unirradiated fuel bundle.

(f) Total was likely rounded down. A more likely quantity is 3.08 Kg (based on same ratio of "Isotope" to "Element" as 7/21/64 shipment).

(g) Total was likely rounded down. A more likely quantity is 1.043 Kg (based on same ratio of "Isotope" to "Element" as 7/21/64 shipment).

Summary PWR-1 Blanket (Natural Uranium) Fuel Received at NRF

Total (Mass) PWR-1 Blanket Fuel Received	**4329.6 Kg Element** 15.325 Kg Isotope **20.742 Kg Plutonium**
Best Estimate Total Mass of Isotope (based on notes on table)	**13.505 Kg Isotope**

Attachment 4

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ID-110 TRASH CASE

(R11-58) WASTE DISPOSAL REQUEST AND AUTHORIZATION

#155

SECTION I - (TO BE COMPLETED BY ORIGINATING ORGANIZATION)

ORIGINATING ORGANIZATION ECF Operations

DESCRIPTION OF WASTE: (Complete applicable parts)

Liquid ____ Solid X Volume 1 cu.yd Weight [redacted]

Radioactive: Yes X No ____ Curies 80

Mr/hr at container surface 50. MR/HR (SWIPED 4"/4") at one meter 5. MR/HR

SS Material Type Zirc clad rods Amount: Net 1.04 Kgs. Isotope Pu239

Classification: Secret None Confidential None Category: I ____ II ____ III ____

Composition: Dissolved PWR rods from Bdl. #0551 absorbed in vermiculite for disposal - 2.48 gms Pu, 1041.6 gms SS, 5.4 gms U^{235}

Capital Equipment No. ____

Associated Hazards: DIRECT RADIATION DURING REMOVAL FROM CASK & PASSAGE HIGH LEVEL S SHIELD

CONTAINER: Type Galvanized metal Destroy To be buried Save ____

MODE OF TRANSPORTATION Phillips AEC Truck

APPROVAL:

	(Signature)	(Title)	(Date)
Originator	[signature]	Supervisor Operations	11/22/60
SS Account. Rep.	[signature]	Security Supervisor	11/22/60
HP Rep.	[signature]	Supervisor ECF IH&SA	11/22/60

SECTION II - (TO BE COMPLETED BY IDO SS MATERIALS SECTION IF SS MATERIALS ARE INVOLVED IN DISPOSAL OPERATION)

Authorization Number ____

(Signature) (Title) (Date)

SECTION III - (TO BE COMPLETED BY IDO HEALTH AND SAFETY DIVISION)

Method of Disposal: Trench #20 Eastend

Prescribed Precautions: NRF - Ind. Hyg. Escort during transfer and disposal responsible for personnel.

APPROVAL:

	(Signature)	(Date)
Site Survey Branch	[signature]	11/22/60
Analytical Branch	____	____
S&FP Branch	____	____

SECTION IV - (TO BE COMPLETED BY PERSON WITNESSING DISPOSAL)

Disposal was made by means of CRANE

at TRENCH #20 9+50 (Location) on 11-23-60 (Date)

[signature] (Signature) 11-23-60 (Date)

NRF618 SR0 11/22/60 [illegible] 30 5
DISPOSAL LOCATION: TRENCH 20

P61ICO1 6864 48340 [illegible] 1960 Tape

UNITED STATES DEPARTMENT OF ENERGY
IDAHO OPERATIONS OFFICE
RADIOACTIVE WASTE FORM

1960

HwB - Correction of WBM input

SECTION 0

0	•	5	1	1	2	2	6	0	0	8	2	0	N	R	F	6	1 8

SECTION 1

50 5	7646E-01	M	8000E+01	

SECTION 2

0	1	27	F	038 VERMICULITE	155	BGT 209+50	1 1 23 60

SECTION 3

CO-60	7985E+01	C
PU-239	2490E+00	G
U-235	5400E+00	G
U-238	1034E+05	G

ID-110 [redacted] 1243 08460
(R11-58) [redacted] . AND AUTHORIZATION [redacted] #167

TRASH CASK-

SECTION I - (TO BE COMPLETED BY ORIGINATING ORGANIZATION)

ORIGINATING ORGANIZATION E. C. F. OPERATIONS

DESCRIPTION OF WASTE: (Complete applicable parts)

Liquid ____ Solid X Volume 1 ft³ Weight ____

Radioactive: Yes X No ____ Curies ~2 ~20 CURIES

Mr/hr at container surface 17 mr/hr (UNSHIELDED) at one meter 1.5 mr/hr

SS Material Type ZIRC CLAD RODS Amount: Net 0.05 G Isotope Pu 239 -2

Classification: Secret NONE Confidential NONE Category: I ____ II ____ III ____

Composition: DISSOLVED ALUM RODS FROM BAL #0551 ABSORBED IN VERMICULITE FOR SHIPMENT

Capital Equipment No. ____

Associated Hazards: DIRECT RADIATION DURING REMOVAL FROM CASK & POSSIBLE HIGH LEVEL CONTAMINATION

CONTAINER: Type GALVANIZED METAL Destroy TO BE BURIED Save ____

MODE OF TRANSPORTATION PHILLIPS E.C.F. TRUCK

APPROVAL:

Originator [signature] Sup. ECF Operations 1/17/61

SS Account. Rep. [signature] SS Materials Representative 1/17/61

HP Rep. [signature] Supervising Hygienist 1/17/61

(Signature) (Title) (Date)

SECTION II - (TO BE COMPLETED BY IDO SS MATERIALS SECTION IF SS MATERIALS ARE INVOLVED IN DISPOSAL OPERATION)

Authorization Number ____

(Signature) (Title) (Date)

SECTION III - (TO BE COMPLETED BY IDO HEALTH AND SAFETY DIVISION)

Method of Disposal: Trench #20

Prescribed Precautions: ECF - Ind. Hygiene control & Coordination transfer and disposal responsible personnel.

APPROVAL:

Site Survey Branch [signature] 1-17-61

Analytical Branch ____

S&FP Branch ____

(Signature) (Date)

SECTION IV - (TO BE COMPLETED BY PERSON WITNESSING DISPOSAL)

Disposal was made by means of Dumping in Trench #20

at 8+50 (Location) on 2/9/61 (Date)

L. J. Cooper (Signature) 2/9/61 (Date)

NRF618 SRO 04/05/61 800 70 c 1243 '08460

ID-110
(R11-58)

WASTE DISPOSAL REQUEST AND AUTHORIZATION

BUNDLES?

SECTION I - (TO BE COMPLETED BY ORIGINATING ORGANIZATION)

ORIGINATING ORGANIZATION ECF Operations

DESCRIPTION OF WASTE: (Complete applicable parts)

Liquid ____ Solid x Volume 1 Yd^3 Weight 100#

Radioactive: Yes x No ____ Curies 40 curies 10

Mr/hr at container surface 70 mr/hr (4" shielded) Probe meter 6 mr/hr

SS Material Type Zirc clad rods loading Amount: Net 520 grams Isotope Pu^{239}

Classification: Secret None Confidential None Category: I ____ II ____ III ____

Composition: Dissolved PWR rods from Blds 3H0109 & 6E0551 absorbed in vermiculite for disposal - 1.24 gms U^{235}, 2.5 gms Pu^{239}, 520 gms S.S.

Capital Equipment No. ____

Associated Hazards: Direct radiation during removal from cask and possible high level contamination spread.

CONTAINER: Type Galvanized metal liner Destroy To be buried Save ____

MODE OF TRANSPORTATION Phillips Petroleum AEC Truck

APPROVAL:

	(Signature)	(Title)	(Date)
Originator	[signature]	Supv. ECF Oper.	4/5/61
SS Account. Rep.	[signature]	SS Mgt Rep.	4/6/61
HP Rep.	[signature]	Engr.	4/5/61

SECTION II - (TO BE COMPLETED BY IDO SS MATERIALS SECTION IF SS MATERIALS ARE INVOLVED IN DISPOSAL OPERATION)

Authorization Number ____

(Signature)	(Title)	(Date)

SECTION III - (TO BE COMPLETED BY IDO HEALTH AND SAFETY DIVISION)

Method of Disposal: Trench #20 Cover after disposal

Prescribed Precautions: NRF-ECF-Ind. Hygiene control to prevent spread of contamination, outside of pit and insure protection of personnel

APPROVAL:

	(Signature)	(Date)
Site Survey Branch	[signature]	4-7-61
Analytical Branch		
S&FP Branch		

SECTION IV - (TO BE COMPLETED BY PERSON WITNESSING DISPOSAL)

Disposal was made by means of Trench burial (Covered)

at 8 + 75 Trench #20 (Location) on 4/12/61 (Date)

[signature] (Signature) 4/12/61 (Date)

NRF61B SRO 04/05/61 810 70 6
DISPOSAL LOCATION: TRENCH 20

1243 08460

ID-110

(R11-58) WASTE DISPOSAL REQUEST AND AUTHORIZATION

#193

SECTION I - (TO BE COMPLETED BY ORIGINATING ORGANIZATION)

ORIGINATING ORGANIZATION ECF Operations

DESCRIPTION OF WASTE: (Complete applicable parts)

Liquid ____ Solid x Volume 1 Yd^3 Weight 100#

Radioactive: Yes x No ____ Curies 40 curies total (.30 curies this Shipment)

Mr/hr at container surface 70 mr/hr (4" shielded) Phone meter 6 mr/hr

SS Material Type Zirc clad rods loaded with Pu^{239} Net 520 grams Isotope Pu^{239}

Classification: Secret None Confidential None Category: I ____ II ____ III ____

Composition: Dissolved PWR rods from bdls. 3H0109 & 6E0551 absorbed in vermiculite for disposal - ~~1.24 gms U^{235}, 2.5 gms Pu^{239}, 520 gms S.S.~~ 390

Capital Equipment No. ____

Associated Hazards: Direct radiation during removal from cask and possible high level contamination spread.

CONTAINER: Type Galvanized metal insert Destroy To be buried Save ____

MODE OF TRANSPORTATION Phillips Petroleum AEC Truck (130 gms = 10 curies to be shipped at later date)

APPROVAL:

Originator	[signature]	Supv. ECF Oper.	4/5/61
SS Account. Rep.	[signature]	SS Mgt Rep	4/6/61
HP Rep.	[signature]	Eng	4-5-61
	(Signature)	(Title)	(Date)

SECTION II - (TO BE COMPLETED BY IDO SS MATERIALS ARE INVOLVED IN DISPOSAL OPERATION) SECTION IF SS MATERIALS

Authorization Number ____

(Signature) (Title) (Date)

SECTION III - (TO BE COMPLETED BY IDO HEALTH AND SAFETY DIVISION)

Method of Disposal: Trench #20 Cover ~~1~~ for disposal

Prescribed Precautions: NRF-ECF-Ind. Hygiene Control during disposal, to prevent spread of contamination and be responsible for protection of personnel.

APPROVAL:

Site Survey Branch	[signature]	4-7-61
Analytical Branch		
S&FP Branch		
	(Signature)	(Date)

SECTION IV - (TO BE COMPLETED BY PERSON WITNESSING DISPOSAL)

Disposal was made by means of Trench Burial (Covered)

at 8+50 - Trench # 20 (Location) on 4/18/61 (Date)

L. D. Cooper (Signature) 4/18/61 (Date)

NRF618 SRO 05/04/62 SIO 10000 250

ID-110 DISPOSAL LOCATION: TRENCH 24 1243 0B460

(R11-58) WASTE DISPOSAL REQUEST AND AUTHORIZATION 302

SECTION I - (TO BE COMPLETED BY ORIGINATING ORGANIZATION)

ORIGINATING ORGANIZATION NRF-ECF OPERATIONS

DESCRIPTION OF WASTE: (Complete applicable parts)

~300 gals

Liquid X Solid X Volume 0.6 yd³ Weight 26,000 lbs Cask

Radioactive: Yes X No Curies 1.8 C

Mr/hr at container surface 10 R/hr at one meter 250 mR/hr

SS Material Type DEPLETED U Amount: Net 2.KG Isotope U 235

Classification: Secret Confidential Category: I II III

Composition: Solid Zr 95 Pieces (15) PWR [illegible] fuel. Nodes (depleted U 238).

Capital Equipment No.

Associated Hazards: Direct radiation and exposure if spilled. H2O gives activity 1.4x10⁻⁴ µc/ml

CONTAINER: Type Pb lined Rack 4' Destroy Save X

MODE OF TRANSPORTATION P.P. Co. Low boy

APPROVAL:

Originator	[signature]	W.P. Sup.	5-4-62
SS Account. Rep.	O.R. Robinson	Technician	5-4-62
HP Rep.	H. Massieu	T.B. Tech	5/4/62
	(Signature)	(Title)	(Date)

SECTION II - (TO BE COMPLETED BY IDO SS MATERIALS SECTION IF SS MATERIALS ARE INVOLVED IN DISPOSAL OPERATION)

Authorization Number

(Signature) (Title) (Date)

SECTION III - (TO BE COMPLETED BY IDO HEALTH AND SAFETY DIVISION)

Method of Disposal: Trench # 26

Prescribed Precautions: NRF-Tech. Hyg. control during transfer and disposal. H2O is unused part of trench. Cover waste with

APPROVAL: soil for subsurface disposal. Approval valid until 6-4-62

Site Survey Branch	[signature]	5-7-62
Analytical Branch		
S&FP Branch		
(Signature)		(Date)

SECTION IV - (TO BE COMPLETED BY PERSON WITNESSING DISPOSAL)

Disposal was made by means of

at OB 3+60 (Location) on 5-8-62 (Date)

[signature] (Signature) 5-8-62 (Date)

NRF618 SR0 05/04/62 B20 100 10
DISPOSAL LOCATION: TRENCH 26

1243 08460

ID-110
(R11-58)

WASTE DISPOSAL REQUEST AND AUTHORIZATION

SECTION I - (TO BE COMPLETED BY ORIGINATING ORGANIZATION)

ORIGINATING ORGANIZATION NRF-ECF- OPERATIONS

DESCRIPTION OF WASTE: (Complete applicable parts)

Liquid ____ Solid X Volume 0.5 m³ Weight 26 000 lbs Crate

Radioactive: Yes X No ____ Curies 384.

Mr/hr at container surface 60 ~~U²³⁵~~ at one meter

SS Material Type ~~U²³⁵~~ Amount: Net 4 KG 1.89% Isotope U 235 1.3

Classification: Secret ____ Confidential ____ Category: I ____ II ____ III ____

Composition: Residues (3) PWR fuel rods absorbed in vermiculite filled bottles.

Capital Equipment No. ____

Associated Hazards: Direct radiation & spread if spilled

CONTAINER: Type Basket 4" Destroy ____ Save X

MODE OF TRANSPORTATION D.P. Co. truck + Low boy

APPROVAL:

Originator L. Macdonald	Sr. Chemist	5/4/62
SS Account. Rep. ORR Brown	Technician	5/4/62
HP Rep. E. Massie	T.H. Tech	5/4/62
(Signature)	(Title)	(Date)

SECTION II - (TO BE COMPLETED BY IDO SS MATERIALS SECTION IF SS MATERIALS ARE INVOLVED IN DISPOSAL OPERATION)

Authorization Number ____

(Signature) (Title) (Date)

SECTION III - (TO BE COMPLETED BY IDO HEALTH AND SAFETY DIVISION)

Method of Disposal: Trench #26

Prescribed Precautions: NRF - Indiv. Hyg. control during trans for ent disposal Approval valid until 6-4-62

APPROVAL:

Site Survey Branch	J. F. Adams	5-7-62
Analytical Branch		
S&FP Branch		
(Signature)		(Date)

SECTION IV - (TO BE COMPLETED BY PERSON WITNESSING DISPOSAL)

Disposal was made by means of Buried Trench #26

at 37-00 (Location) on 5-8-62 (Date)

W. C. Richards 5-8-62
(Signature) (Date)

NRF618 SRO 06/29/62 820 250 25
DISPOSAL LOCATION: TRENCH 26

1243 08460

ID-110
(R11-58) WASTE DISPOSAL REQUEST AND AUTHORIZATION

SECTION I - (TO BE COMPLETED BY ORIGINATING ORGANIZATION)

ORIGINATING ORGANIZATION NRF - ECF Operations

DESCRIPTION OF WASTE: (Complete applicable parts)

Liquid ____ Solid X Volume 0.5 yd³ Weight 26000 lb Cask
Radioactive: Yes X No ____ Curies 150.
Mr/hr at container surface 250. at one meter 23 U²³⁵ 8.2 grams
SS Material Type U²³⁵ Amount: Net U 38.665 grams Isotope Pu²³⁹ 25.8 grams
Classification: Secret ____ Confidential ____ Category: I ____ II ____ III ____
Composition: (5) PuO₂ rods Sealed, contained in vermiculite filled poly bottles.
Capital Equipment No. ____
Associated Hazards: Direct radiation + Pu spread if spilled

CONTAINER: Type 4' thick Pb cask Destroy ____ Save X
MODE OF TRANSPORTATION P.P.Co. Loading + Transfer
APPROVAL: MEET S APPROVED
Originator LETTER # NRFE-P 325 D. Pogue for B. Singer
SS Account. Rep. O.R. Robinson W.P. Leech 6/29/62
HP Rep. E. Mastrud I. N. Stark 6/29/62
(Signature) (Title) (Date)

SECTION II - (TO BE COMPLETED BY IDO SS MATERIALS SECTION IF SS MATERIALS ARE INVOLVED IN DISPOSAL OPERATION)

Authorization Number ____
(Signature) (Title) (Date)

SECTION III - (TO BE COMPLETED BY IDO HEALTH AND SAFETY DIVISION)

Method of Disposal: Trench # 26
Prescribed Precautions: Ind. Hyg. (NRF) Control during transp and disposal. Coordinate with PPCo personnel
APPROVAL: If their people are involved. Complete form
Site Survey Branch ____
Analytical Branch ____
S&FP Branch J. W. Ballard 6-29-62
(Signature) (Date)

SECTION IV - (TO BE COMPLETED BY PERSON WITNESSING DISPOSAL)

Disposal was made by means of Burial Trench # 26
at 17+60 (Location) on 7-10-62 (Date)
Jerry Hockwalt 7-10-62
(Signature) (Date)

NRF618 SRO 08/02/62 800 120 13
DISPOSAL LOCATION: TRENCH 26

[redacted] 1243 [redacted] 08460

ID-110
(R11-58)

WASTE DISPOSAL REQUEST AND AUTHORIZATION

SECTION I - (TO BE COMPLETED BY ORIGINATING ORGANIZATION)

ORIGINATING ORGANIZATION NRE-ECF - Operations

DESCRIPTION OF WASTE: (Complete applicable parts)

Liquid ____ Solid X Volume 0.5 yds Weight ____

Radioactive: Yes X No ____ Curies ~120

Mr/hr at container surface 120 mm/hr. at one meter 1-4 2.38 grams U^{238} 237

SS Material Type U 238 Amount: Net 532 grams U^{238} Isotope 1.77 grams U 235

Classification: Secret ____ Confidential ____ Category: I ____ II ____ III ____

Composition: Discarded P.W.R. fuel rods, absorbed in Vermiculite filled bottles. (4) Rods

Capital Equipment No. ____

Associated Hazards: Direct radiation and ☣ spread if spilled

CONTAINER: Type 4" Pb trash casks Destroy ____ Save X

MODE OF TRANSPORTATION P.P. Co. Tractor & Low boy

APPROVAL:

	(Signature)	(Title)	(Date)
Originator	[signature]	Supervisor	8/2/62
SS Account. Rep.	O.K. Robinson	Technician	8-2-62
HP Rep.	D. Massini	T.H. Tech	8/2/62

SECTION II - (TO BE COMPLETED BY IDO SS MATERIALS SECTION IF SS MATERIALS ARE INVOLVED IN DISPOSAL OPERATION)

Authorization Number ____

(Signature)	(Title)	(Date)

SECTION III - (TO BE COMPLETED BY IDO HEALTH AND SAFETY DIVISION)

Method of Disposal: Trench #26 (Separate from load #331)

Prescribed Precautions: NRF - Ind. Hyg. control during transfer and disposal. Coordinate with PPCo if their personnel are involved. Complete Form.

APPROVAL:

	(Signature)	(Date)
Site Survey Branch	Jas. A. Osborn	8/6/62
Analytical Branch		
S&FP Branch		

SECTION IV - (TO BE COMPLETED BY PERSON WITNESSING DISPOSAL)

Disposal was made by means of Burial Trench #26

at 1+27 (Location) on 8-6-62 (Date)

Jack Clark (Signature) 8-6-62 (Date)

NRF418 SRO 08/03/62 810 125 13
DISPOSAL LOCATION: TRENCH 26

1243 08460

ID-110
(R11-58)

WASTE DISPOSAL REQUEST AND AUTHORIZATION

SECTION I - (TO BE COMPLETED BY ORIGINATING ORGANIZATION)

ORIGINATING ORGANIZATION NRF-ECF-Operations

DESCRIPTION OF WASTE: (Complete applicable parts)

Liquid ____ Solid X Volume 0.5 yd³ Weight ____

Radioactive: Yes X No ____ Curies 36.0 C est

Mr/hr at container surface 125 mr/hr at one meter 3. 72 grams Pu 239

SS Material Type U 238 Amount: Net 1594 grams U 238 Isotope 5.3 grams U 235

Classification: Secret ____ Confidential ____ Category: I ____ II ____ III ____

Composition: (12) Solid P.W.R. fuel Rods contained in in a burial insert

Capital Equipment No. ____

Associated Hazards: Direct radiation & c spread if spilled

CONTAINER: Type 4" Pb trash cask Destroy ____ Save X

MODE OF TRANSPORTATION P.P. Co. tractor & low Boy

APPROVAL:

	(Signature)	(Title)	(Date)
Originator	[signature]	Supervisor	8/3/62
SS Account. Rep.	[signature]	Technician	8/3/62
HP Rep.	[signature]	I.H. Tech	8/3/62

SECTION II - (TO BE COMPLETED BY IDO SS MATERIALS SECTION IF SS MATERIALS ARE INVOLVED IN DISPOSAL OPERATION)

Authorization Number ____

(Signature) (Title) (Date)

SECTION III - (TO BE COMPLETED BY IDO HEALTH AND SAFETY DIVISION)

Method of Disposal: Trench #26 (separate from load #330)

Prescribed Precautions: NRF - Ind. Hyg. escort + control for transfer + disposal. Coordinate with PPCo if necessary.

APPROVAL: Complete Form

	(Signature)	(Date)
Site Survey Branch	[signature]	8/6/62
Analytical Branch		
S&FP Branch		

SECTION IV - (TO BE COMPLETED BY PERSON WITNESSING DISPOSAL)

Disposal was made by means of Burial Trench #26

at 2-105 (Location) on 8-7-62 (Date)

Larry Hochwirt (Signature) 8-7-62 (Date)

NRF618 SRO 10/24/62 800 150 50
DISPOSAL LOCATION: TRENCH 27

ID-110   1243   08460

(R11-58)

WASTE DISPOSAL REQUEST AND AUTHORIZA[illegible]

4" Pb trash cask

SECTION I - (TO BE COMPLETED BY ORIGINATING ORGANIZATION)

ORIGINATING ORGANIZATION NRF-ECF Operations

DESCRIPTION OF WASTE: (Complete applicable parts)

Liquid ____ Solid X Volume 0.5 yd³ Weight ____

Radioactive: Yes X No ____ Curies ~150

Mr/hr at container surface 150. at one meter 50 [illegible]

SS Material Type U 238 / Amount: Net 665 grams U 238 Isotope [illegible] grams Pu 239 [illegible]

Classification: Secret None Confidential ____ Category: I ____ II ____ III ____

Composition: Dissolved PWR rod (fuel) absorbed in vermiculite filled bottles (5 rods)

Capital Equipment No. ____

Associated Hazards: Direct radiation when unloaded & spread if spilled

CONTAINER: Type 4" Pb trash cask Destroy ____ Save X

MODE OF TRANSPORTATION P.P. Co. tractor & low boy

APPROVAL:

	(Signature)	(Title)	(Date)
Originator	Michael J. [illegible]	Chemist	Oct 24, 1962
SS Account. Rep.	[illegible]	Technician	10-24-62
HP Rep.	B. [illegible]	[illegible]	10/24/62

SECTION II - (TO BE COMPLETED BY IDO SS MATERIALS SECTION IF SS MATERIALS ARE INVOLVED IN DISPOSAL OPERATION)

Authorization Number ____

(Signature) (Title) (Date)

SECTION III - (TO BE COMPLETED BY IDO HEALTH AND SAFETY DIVISION) ECF-365

Method of Disposal: Trench #27 or #29

Prescribed Precautions: Coordinate with PP Co.-H.P. for control during disposal at the Burial Ground.

APPROVAL:

	(Signature)	(Date)
Site Survey Branch	[illegible]	10/25/62
Analytical Branch		
S&FP Branch		

SECTION IV - (TO BE COMPLETED BY PERSON WITNESSING DISPOSAL)

Disposal was made by means of BURIAL TRENCH #27

at 8+00 (Location) on 10-30-62 (Date)

R. Fielding (Signature) 10-30-62 (Date)

NRF618 SRO 11/29/62 800 150 90

ID-11(DISPOSAL LOCATION: TRENCH 27

(R11-58) WASTE DISPOSAL REQUEST

1243 08460

SECTION I - (TO BE COMPLETED BY ORIGINATING ORGANIZATION)

ORIGINATING ORGANIZATION NRF-ECF- Chemistry

DESCRIPTION OF WASTE: (Complete applicable parts)

Liquid ____ Solid X Volume 0.5 ft³ Weight ____

Radioactive: Yes X No ____ Curies ~150.

Mr/hr at container surface 150. at one meter ____

SS Material Type U 235 Amount: Net 665 gms U 235 Isotope ____

Classification: Secret ____ Confidential ____ Category: I ____ II ____ III ____

Composition: Dissolved PWR fuel rods (5) absorbed in Vermiculite filled poly bottles

Capital Equipment No. ____

Associated Hazards: Fissile radiation contamination if spread if spilled

CONTAINER: Type 4" Pb Cube Destroy ____ Save X

MODE OF TRANSPORTATION P.P. Co. truck + hand buggy

APPROVAL:

Originator	D. MacDonald	Chemist	11/29/62
SS Account. Rep.	O.K. Robinson	WP Tech.	11/29/62
HP Rep.	G. Mansard	I. H. Tech	11/29/62
	(Signature)	(Title)	(Date)

SECTION II - (TO BE COMPLETED BY IDO SS MATERIALS SECTION IF SS MATERIALS ARE INVOLVED IN DISPOSAL OPERATION)

Authorization Number ____

(Signature) (Title) (Date)

SECTION III - (TO BE COMPLETED BY IDO HEALTH AND SAFETY DIVISION)

Method of Disposal: Trench #27

Prescribed Precautions: Coordinate with PPL during disposal.

APPROVAL:

Site Survey Branch ____

Analytical Branch ____

S&FP Branch ____

(Signature) (Date)

SECTION IV - (TO BE COMPLETED BY PERSON WITNESSING DISPOSAL)

Disposal was made by means of Burial Trench

at 7+00 (Location) on 11/29/62 (Date)

R. Fielding (Signature) (Date)

NRF618 SRO 06/16/64 1 100 5
DISPOSAL LOCATION: TRENCH 34

ECF TRASH CASK

ID-110
(R11-58)

WASTE DISPOSA[L] 1243 [R]ES[ID] 08461 [AU]THORIZATION

WASTE DISPOSAL # 653

SECTION I - (TO BE COMPLETED BY ORIGINATING ORGANIZATION)

ORIGINATING ORGANIZATION NRF ECF OPERATIONS

DESCRIPTION OF WASTE: (Complete applicable parts) NOTE: The waste container is an ICC-5e 30 drum. Drum contains

Liquid ____ Solid X ____ Volume 3 ft³ Weight 2.5 gallon absorbed waste.

Radioactive: Yes X No ____ Curies Approx. 60, Total

Mr/hr at container surface 100 at one meter 5.

SS Material Type * See below Amount: Net ____ Isotope ____

Classification: Secret ____ Confidential ____ Category: I ____ II ____ III ____

Composition: (One 25 gal drum spec. ICC-5e 30) containing 2.5 gallon dissolved SS material as noted absorbed in vermiculite.

Capital Equipment No. [illegible]

Associated Hazards: DIRECT RADIATION AND CONTAMINATION SPREAD IF SPILLED.

CONTAMINATION: Type ____ Pb trash cask Destroy ____ Save X

MODE OF TRANSPORTATION F. P. Co truck and trailer.

APPROVAL:

* 268 Grams Normal Uranium U^{238}

1.25 Grams Pu^{239} + 0.18 Grams U^{235}.

Originator [signature]

SS Account. Rep. A. H. [signature] Shift supervisor ADM 5/28/64

HP Rep. [signature] Rad-Con Tech 5/28/64

(Signature) (Title) (Date)

SECTION II - (TO BE COMPLETED BY IDO SS MATERIALS SECTION IF SS MATERIALS ARE INVOLVED IN DISPOSAL OPERATION)

Authorization Number ____

(Signature) (Title) (Date)

SECTION III - (TO BE COMPLETED BY IDO HEALTH AND SAFETY DIVISION)

NRF-653

Method of Disposal: Trench

Prescribed Precautions: Escort if radiation > 500 mr/hr at 1 meter. Dispose of drum so that it remains in an upright position when covered with soil. Coordinate with PPCo.

APPROVAL:

Site Survey Branch [signature] 6-1-64

Analytical Branch ____

S&FP Branch ____

(Signature) (Date)

SECTION IV - (TO BE COMPLETED BY PERSON WITNESSING DISPOSAL)

Disposal was made by means of Trench #34

at 9420 on 6-16-64

(Location) (Date)

[signature] 6-16-64

(Signature) (Date)

HRF&IB SRO 06/04/65 820 3000 400
DISPOSAL LOCATION: TRENCH 36

1880 17226

FORM ID-110 (11-64)

U. S. ATOMIC ENERGY COMMISSION
IDAHO OPERATIONS OFFICE
WASTE DISPOSAL REQUEST AND AUTHORIZATION

REFERENCE (IDM 0500-7)

SECTION I

ORIGINATING ORGANIZATION ECF Operations

DESCRIPTION OF WASTE: (ORIGINATING ORGANIZATION COMPLETE APPLICABLE PARTS)

LIQUID ☐ SOLID ☒ VOLUME 16ft³ WEIGHT

RADIOACTIVE: YES ☒ NO ☐ CURIES 1,3210

MR/HR AT CONTAINER SURFACE 9 R/hr AT ONE METER 400 mr/hr

COMPOSITION: Irradiated Core components, wear strips, end boxes. 12 PWR rods 1.59 kg Natural Uranium, 5gm Pu.

ASSOCIATED HAZARDS Direct Radiation & % spread if contents spilled

SS MATERIAL TYPE AMOUNT: NET ISOTOPE

CLASSIFICATION: SECRET ☐ CONFIDENTIAL ☐ CATEGORY: I II III

CAPITAL EQUIPMENT NO. DISPOSAL NO.

CONTAINER: TYPE Lead Cask Export DESTROY ☒ SAVE ☐

MODE OF TRANSPORTATION AP Co. Truck

APPROVAL:

ORIGINATOR

SS ACCOUNT. REP. Jas. E. Hall Emmett J. Symm 6/4/65

HP REP. (SIGNATURE) (TITLE) (DATE)

SECTION II – (TO BE COMPLETED BY ID SS MATERIALS OFFICER ONLY IF SS MATERIALS ARE INVOLVED)

AUTHORIZATION NUMBER

(SIGNATURE) (TITLE) (DATE)

SECTION III – (FOR USE OF IO HEALTH AND SAFETY DIVISION)

METHOD OF DISPOSAL: TRENCH ☐ PIT ☐ OTHER

PRESCRIBED PRECAUTIONS:

APPROVAL:

WASTE MANAGEMENT BR. (SIGNATURE) (DATE)

ANALYTICAL BR. (SIGNATURE) (DATE)

HAZARDS CONTROL BR. (SIGNATURE) (DATE)

SECTION IV – (TO BE COMPLETED BY PERSON WITNESSING DISPOSAL)

DISPOSAL WAS MADE BY MEANS OF Trench E-32

AT 9-0 (LOCATION) ON 6/24/65 (DATE)

(SIGNATURE) (DATE)

NRF618 SRO 06/26/67 820 100 1.

BxB462 E-150

FORM ID – 110 (11 – 64)	U. S. ATOMIC ENERGY COMMISSION IDAHO OPERATIONS OFFICE WASTE DISPOSAL REQUEST AND AUTHORIZATION	REFERENCE IDM 0500 – 7

SECTION I

ORIGINATING ORGANIZATION NRTS-NRF-ECF-OPERATIONS

DESCRIPTION OF WASTE: (ORIGINATING ORGANIZATION COMPLETE APPLICABLE PARTS)

LIQUID ☐ SOLID ☒ VOLUME 16 Cu. ft. WEIGHT 125 lbs.

RADIOACTIVE: YES ☒ NO ☐ CURIES 10

MR/HR AT CONTAINER SURFACE 1,000 mr/hr AT ONE METER 1.0 mr/hr

COMPOSITION: 20 each expended PWR fuel rods in a banded stainless Steel container.

ASSOCIATED HAZARDS Highly contaminated and radiation field in event of a spill.

SS MATERIAL TYPE Natural AMOUNT: NET 2,680 gms. ISOTOPE Pu 15%

CLASSIFICATION: SECRET ☐ CONFIDENTIAL ☐ CATEGORY: I ___ II ___ III ___

CAPITAL EQUIPMENT NO. _____ DISPOSAL NO. _____

CONTAINER: TYPE Lead and steel cask DESTROY ☐ SAVE ☒

MODE OF TRANSPORTATION INC truck.

APPROVAL:

	(SIGNATURE)	(TITLE)	(DATE)
SAFETY	R. Paterson		6/28/67
ORIGINATOR	C. P. Patterson	Supv. ECF Op Support	6/26/67
SS ACCOUNT REP.	[illegible]	ECF SS MAT ADM	6/27/67
HP REP.	R. Bryson + C. Pritchett	Health Tech	6/27/67

Inventory of 6/27/67

SECTION II – (TO BE COMPLETED BY ID SS MATERIALS OFFICER ONLY IF SS MATERIALS ARE INVOLVED)

AUTHORIZATION NUMBER _____

(SIGNATURE)	(TITLE)	(DATE)

SECTION III – (FOR USE OF ID HEALTH AND SAFETY DIVISION)

METHOD OF DISPOSAL: TRENCH ☒ PIT ☐ OTHER _____

PRESCRIBED PRECAUTIONS: Coordinate disposal arrangements with INC. CF- H.P. Office.

APPROVAL:

	(SIGNATURE)	(DATE)
WASTE MANAGEMENT BR.	J. A. Olson	6/27/67
ANALYTICAL BR.		
HAZARDS CONTROL BR.		

SECTION IV – (TO BE COMPLETED BY PERSON WITNESSING DISPOSAL)

DISPOSAL WAS MADE BY MEANS OF Trench # 45

AT T & 65 (LOCATION) ON _____ (DATE)

W. T. Brayton (SIGNATURE) 6-28-67 (DATE)

MRF618 BRO 06/10/68 830 125 15
DISPOSAL LOCATION: TRENCH 47

1243 08463

FORM ID-110 (11-64)	U. S. ATOMIC ENERGY COMMISSION IDAHO OPERATIONS OFFICE WASTE DISPOSAL REQUEST AND AUTHORIZATION	REFERENCE IDM 0800-7 E-105

SECTION I

ORIGINATING ORGANIZATION ECF WATER PITS, SCOVILLE, IDAHO

DESCRIPTION OF WASTE: (ORIGINATING ORGANIZATION COMPLETE APPLICABLE PARTS)

LIQUID ☐ SOLID ☒ VOLUME ~~16 cu ft.~~ WEIGHT 26,000 lbs.

RADIOACTIVE: YES ☒ NO ☐ CURIES 900

MR/HR AT CONTAINER SURFACE 125 AT ONE METER 15

COMPOSITION: SCRAPE INSERT #83 CONTAINING PWR BUNDLES # 0291, AND # 0381, AND MISC CORE HARDWARE

ASSOCIATED HAZARDS RADIATION AND CONTAMINATION SPREAD IF SPILLED.

Each Bundle contains 15.84 KG Natural, .04 KG U 235, 82 grams Pu.

SS MATERIAL TYPE NATURAL AMOUNT: NET ISOTOPE

CLASSIFICATION: SECRET ☐ CONFIDENTIAL ☐ CATEGORY: I II III

CAPITAL EQUIPMENT NO. NA DISPOSAL NO. E-105

CONTAINER: TYPE SCRAP CASK DESTROY ☐ SAVE ☒

MODE OF TRANSPORTATION INC TRUCK

APPROVAL: SAFETY:

	(SIGNATURE)	(TITLE)	(DATE)
ORIGINATOR	John E. Howell	Shift Engr.	6/10/68
SS ACCOUNT. REP.	[illegible]	ECF SS MATERIALS	6-10-68
HP REP.	[illegible]	Rad Con Tech	6-10-68

SECTION II – (TO BE COMPLETED BY ID SS MATERIALS OFFICER ONLY IF SS MATERIALS ARE INVOLVED)

AUTHORIZATION NUMBER

(SIGNATURE) (TITLE) (DATE)

SECTION III – (FOR USE OF ID HEALTH AND SAFETY DIVISION)

METHOD OF DISPOSAL: TRENCH ☒ PIT ☐ OTHER

PRESCRIBED PRECAUTIONS: See attached sheet

APPROVAL:

	(SIGNATURE)	(DATE)
~~WASTE MANAGEMENT~~ Envir. BR.	J. R. Odom	6/11/68
ANALYTICAL BR.		
HAZARDS CONTROL BR.		

SECTION IV – (TO BE COMPLETED BY PERSON WITNESSING DISPOSAL)

DISPOSAL WAS MADE BY MEANS OF

AT Trench # 47 Lot 10 (LOCATION) ON 6-14-68 (DATE)

R. Schenck (SIGNATURE) 6-14-68 (DATE)

Rejected as dry by ECF on July 1243 08463

NRF&IB SRO 06/19/68 810 150 40
DISPOSAL LOCATION: TRENCH 47

(11-64) | U.S. ATOMIC ENERGY COMMISSION IDAHO OPERATIONS OFFICE | REFERENCE IDM 0500-7

WASTE DISPOSAL REQUEST AND AUTHORIZATION

E 108

SECTION I

ORIGINATING ORGANIZATION ECF WATER PITS, SCOVILLE, IDAHO

DESCRIPTION OF WASTE: (ORIGINATING ORGANIZATION COMPLETE APPLICABLE PARTS)

LIQUID ☐ SOLID ☒ VOLUME 16 Cubic Feet WEIGHT 26,000 lbs.

RADIOACTIVE: YES ☒ NO ☐ CURIES 1360 excess (Curies of Europium-110)

MR/HR AT CONTAINER SURFACE 150. AT ONE METER 40.

COMPOSITION: SCRAP INSERT # 55 CONTAINING PWR BUNDLES # 0750 and # 0495 AND MISC CORE AND LOOP HARDWARE.

ASSOCIATED HAZARDS RADIATION AND CONTAMINATION SPREAD IF SPILLED

*EACH BUNDLE CONTAINS 15.84 KG NATURAL, .04 KG U-235, 82 gms Pu

SS MATERIAL TYPE NATURAL AMOUNT: NET ISOTOPE

CLASSIFICATION: SECRET ☐ CONFIDENTIAL ☐ CATEGORY: I ___ II ___ III ___

CAPITAL EQUIPMENT NO. NA DISPOSAL NO.

CONTAINER: TYPE SCRAP CASK DESTROY ☐ SAVE ☒

MODE OF TRANSPORTATION INC TRUCK

APPROVAL:

	(SIGNATURE)	(TITLE)	(DATE)
SAFETY:	[signature]	~~SHIFT~~ ENGINEER	6-19-68
ORIGINATOR	John F. Howell	SHIFT ENGINEER	6-19-68
SS ACCOUNT REP.	[signature]	ECF SS MAT MGR	6-19-68
HP REP.	[signature]	RAD CON TECH	6-19-68

SECTION II – (TO BE COMPLETED BY ID SS MATERIALS OFFICER ONLY IF SS MATERIALS ARE INVOLVED)

AUTHORIZATION NUMBER ___

(SIGNATURE) (TITLE) (DATE)

SECTION III – (FOR USE OF ID HEALTH AND SAFETY DIVISION)

METHOD OF DISPOSAL: TRENCH ☐ PIT ☐ OTHER ___

PRESCRIBED PRECAUTIONS: ___

APPROVAL:

	(SIGNATURE)	(DATE)
WASTE MANAGEMENT BR.	___	___
ANALYTICAL BR.	___	___
HAZARDS CONTROL BR.	___	___

SECTION IV – (TO BE COMPLETED BY PERSON WITNESSING DISPOSAL)

DISPOSAL WAS MADE BY MEANS OF Trench - 47

AT 94 95 (LOCATION) ON (DATE)

[signature] (SIGNATURE) 6-19-68 (DATE)

WRF618 SRO 06/20/68 800 3000 450
DISPOSAL LOCATION: TRENCH 47

1880 17229

FORM ID - 110 (11-64)	U. S. ATOMIC ENERGY COMMISSION IDAHO OPERATIONS OFFICE WASTE DISPOSAL REQUEST AND AUTHORIZATION	REFERENCE IDM 0500-7 6110

SECTION I

ORIGINATING ORGANIZATION ECF WATER PITS, SCOVILLE, IDAHO

DESCRIPTION OF WASTE: (ORIGINATING ORGANIZATION COMPLETE APPLICABLE PARTS)

Truck Load Ca...

LIQUID ☐ SOLID ☒ VOLUME 16 Cubic Feet WEIGHT 26,000 lbs.

RADIOACTIVE: YES ☒ NO ☐ CURIES 24 gms (1.0 curies of fuel)

MR/HR AT CONTAINER SURFACE 4000 AT ONE METER 450

COMPOSITION: SCRAP INSERT # 72 CONTAINING FOR BUNDLES # 0044 and # 0468 ,and S&W MISC HARDWARE

ASSOCIATED HAZARDS: RADIATION AND CONTAMINATION SPREAD IF SPILLED.

BUNDLES CONTAIN 35.84 KG NATURAL, .04 Kg U-235, 72 gms Pu.

SS MATERIAL TYPE NATURAL AMOUNT: NET ISOTOPE

CLASSIFICATION: SECRET ☐ CONFIDENTIAL ☒ CATEGORY: I ___ II ___ III ___

CAPITAL EQUIPMENT NO. NA DISPOSAL NO.

CONTAINER: TYPE SCRAP INSERT DESTROY ☐ SAVE ☒

MODE OF TRANSPORTATION ING TRUCK

APPROVAL:	SAFETY:		
		SHIFT ENGINEER	6-20-6 8
ORIGINATOR	John E. Howell	SHIFT ENGINEER	6-20-68
SS ACCOUNT REP.	Gardner	ECF SS MAT ADM	6-20-68
HP REP.		RAD-CON TECH	6-20-68
	(SIGNATURE)	(TITLE)	(DATE)

SECTION II – (TO BE COMPLETED BY ID SS MATERIALS OFFICER ONLY IF SS MATERIALS ARE INVOLVED)

AUTHORIZATION NUMBER

(SIGNATURE) (TITLE) (DATE)

SECTION III – (FOR USE OF ID HEALTH AND SAFETY DIVISION)

METHOD OF DISPOSAL: TRENCH ☐ PIT ☐ OTHER

PRESCRIBED PRECAUTIONS:

APPROVAL:

WASTE MANAGEMENT SR. (SIGNATURE) (DATE)

ANALYTICAL SR. (SIGNATURE) (DATE)

HAZARDS CONTROL SR. (SIGNATURE) (DATE)

SECTION IV – (TO BE COMPLETED BY PERSON WITNESSING DISPOSAL)

DISPOSAL WAS MADE BY MEANS OF Trench - 47

AT (LOCATION) ON (DATE)

WF French (SIGNATURE) 8/21/68 (DATE)

NRF618 SRO 06/24/68 820 4000 250
DISPOSAL LOCATION: TRENCH 47

1243 | 08463

FORM ID-110 (11-64)	U. S. ATOMIC ENERGY COMMISSION IDAHO OPERATIONS OFFICE WASTE DISPOSAL REQUEST AND AUTHORIZATION	REFERENCE IDM 6300-7 E-117

SECTION I

ORIGINATING ORGANIZATION ECF WATER Pits, Scoville IDAHO

DESCRIPTION OF WASTE: (ORIGINATING ORGANIZATION COMPLETE APPLICABLE PARTS)

LIQUID ☐ SOLID ☒ VOLUME 16CU ft. WEIGHT 26,000 LBS

RADIOACTIVE: YES ☒ NO ☐ CURIES 6.0 X 10^3

MR/HR AT CONTAINER SURFACE 4 RHR AT ONE METER 260

COMPOSITION: SCRAP INCERT # 88 CONTAINING 2 PWR Bundles # 0015 & 0504 AND MISC SCRAP HARDWARE.

ASSOCIATED HAZARDS RADITION & CONTAMINATION IF Spilled.

EACH BUNDLE CONTAINS: 15.8 Kg Natural, 0 Kg. U-235, 82gms. Pu.

SS MATERIAL TYPE NATURAL AMOUNT: NET _____ ISOTOPE _____

CLASSIFICATION: SECRET ☐ CONFIDENTIAL ☐ CATEGORY: I ___ II ___ III ___

CAPITAL EQUIPMENT NO. NA DISPOSAL NO. _____

CONTAINER: TYPE SCRAP CASK DESTROY ☐ SAVE ☒

MODE OF TRANSPORTATION INC TRUCK

APPROVAL: SAFETY: [signature] 6-24-68

	(SIGNATURE)	(TITLE)	(DATE)
ORIGINATOR	[signature]	Shift Supv.	6-24-68
SS ACCOUNT. REP.	[signature]	ESF-SS MAT. ADM	6-24-68
HP REP.	[signature]	Rad-Protech	6-24-68

SECTION II – (TO BE COMPLETED BY ID SS MATERIALS OFFICER ONLY IF SS MATERIALS ARE INVOLVED)

AUTHORIZATION NUMBER _____

(SIGNATURE) (TITLE) (DATE)

SECTION III – (FOR USE OF ID HEALTH AND SAFETY DIVISION)

METHOD OF DISPOSAL: TRENCH ☐ PIT ☐ OTHER _____

PRESCRIBED PRECAUTIONS: _____

APPROVAL:

WASTE MANAGEMENT BR. _____ (SIGNATURE) _____ (DATE)

ANALYTICAL BR. _____ (SIGNATURE) _____ (DATE)

HAZARDS CONTROL BR. _____ (SIGNATURE) _____ (DATE)

SECTION IV – (TO BE COMPLETED BY PERSON WITNESSING DISPOSAL)

DISPOSAL WAS MADE BY MEANS OF Trench No. 47

AT 9+25 (LOCATION) ON _____ (DATE)

[signature] (SIGNATURE) 6-24-68 (DATE)

NRF618 SRO 06/25/68 800 2000 200
DISPOSAL LOCATION: TRENCH 47

1243 08463

FORM ID – 110 (11 – 64)	U. S. ATOMIC ENERGY COMMISSION IDAHO OPERATIONS OFFICE WASTE DISPOSAL REQUEST AND AUTHORIZATION	REFERENCE IDM 0800 – 7 E-118

SECTION I

ORIGINATING ORGANIZATION ECF WATER PITS SCOVILLE IDAHO

DESCRIPTION OF WASTE: (ORIGINATING ORGANIZATION COMPLETE APPLICABLE PARTS)

LIQUID ☐ SOLID ☒ VOLUME 16 CU FT. WEIGHT 26,000 LBS

RADIOACTIVE: YES ☒ NO ☐ CURIES 2 gram (85 grams of fuel) 200

MR/HR AT CONTAINER SURFACE 2000 AT ONE METER

COMPOSITION: MTSC HARDWARE FROM S5W DISPOSAL EFFORT ALSO TWO PWR ROD BUNDLES 0116 and 0114. Quantity 2#

ASSOCIATED HAZARDS RADIATION AND CONTAMINATION IF SPILLED.

EACH BUNDLE CONTAINS 15.81 Kg NATURAL, .04 Kg U-235, 82 gms. Pu

SS MATERIAL TYPE NATURAL AMOUNT: NET ISOTOPE

CLASSIFICATION: SECRET ☐ CONFIDENTIAL ☐ CATEGORY: I ___ II ___ III ___

CAPITAL EQUIPMENT NO. N/A DISPOSAL NO. E-118

CONTAINER: TYPE SCRAP INSERT DESTROY ☐ SAVE ☒

MODE OF TRANSPORTATION INC TRUCK

APPROVAL:			
SAFETY ORIGINATOR		Shift Supv.	6-25-68
SS ACCOUNT REP.		Shift Supv.	6-25-68
HP REP.		ECF SS MAT ADM	6-25-68
	(SIGNATURE)	(TITLE)	(DATE)

SECTION II – (TO BE COMPLETED BY ID SS MATERIALS OFFICER ONLY IF SS MATERIALS ARE INVOLVED)

AUTHORIZATION NUMBER

(SIGNATURE) (TITLE) (DATE)

SECTION III – (FOR USE OF ID HEALTH AND SAFETY DIVISION)

METHOD OF DISPOSAL: TRENCH ☐ PIT ☐ OTHER

PRESCRIBED PRECAUTIONS:

APPROVAL:

WASTE MANAGEMENT SR. (SIGNATURE) (DATE)

ANALYTICAL SR. (SIGNATURE) (DATE)

HAZARDS CONTROL SR. (SIGNATURE) (DATE)

SECTION IV – (TO BE COMPLETED BY PERSON WITNESSING DISPOSAL)

DISPOSAL WAS MADE BY MEANS OF TRENCH 47

AT 9 & 20 (LOCATION) ON (DATE)

(SIGNATURE) 6/24/68 (DATE)

Attachment 5

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Summary of Shipping Records to RWMC Related to Irradiated Shippingport Fuel

Date	Disposition Number	Description (as given on shipping record)	Fuel Mat'l (Y/N)	Container	Vol. (yd^3)	Wt. (lbs)	Radiation Levels[a]	Curies	Isotopes	Disposal Location	Hard Copy of Shipping Record?	Other
11/22/60	155	Dissolved PWR rods from Bdl. #0551 absorbed in vermiculite inside metal container	Y	NL	1	NL	NL	80	Zr^{95} Pu^{239} (2.48 gms) U^{235} (5.4 gms) U^{238} (1034 gms) Co^{60}	Trench #20	Yes	
1/17/61	167	Dissolved PWR Rods from Bdl #0551 absorbed in vermiculite for disposal.	Y	Galvanize Metal	1	NL	17 mr/hr	30	Pu^{239} (0.5 gms)	Trench #20	Yes	Signed for S.S. accountability
4/5/61	193	Dissolved PWR rods from Blds 3H0109 & 6E0551 absorbed in vermiculite for disposal	Y	Galvanize Metal Insert	1	100	70 mr/hr	10	U^{235} (1.24 gms) Pu^{239} (2.5 gms) U^{238} (520 gms)	Trench #20	Yes	Signed for S.S. accountability
4/5/61	193	Dissolved PWR rods from blds 3H0109 & 6E0551 absorbed in vermiculite for disposal	Y	Galvanize Metal Insert	1	100	70 mr/hr	30	U^{235} (1.24 gms) Pu^{239} (2.5 gms) U^{238} (520 gms)	Trench #20	Yes	Signed for S.S. accountability
5/4/62	302	Solid Zr^{95} pieces (15) PWR Fuel Rods (depleted U^{238})	Y	Lead Cask	0.6	26,000	10 R/hr 250 mr/hr	2.8	U^{238} (2 Kg) Pu^{239} (5 gms) U^{235} (10.13 gms)	Trench #26	Yes	Signed for S.S. accountability, 300 gal. of water
5/4/62	303	Dissolved (3) PWR Fuel rods absorbed in vermiculite filled bottles	Y	Lead Cask	0.5	26,000	100 mr/hr	384	U^{238} (0.4 Kg) Pu^{239} (1.8 gms) U^{235} (2.2 gms)	Trench #26	Yes	Signed for S.S. accountability
6/29/62	320	(5) PWR rods dissolved contained in vermiculite filled bottles	Y	Lead Cask	0.5	26,000	250 mr/hr 25 mr/hr	150	U^{238} (668 gms) Pu^{239} (2.98 gms) U^{235} (2.21 gms)	Trench #26	Yes	Signed for S.S. accountability, states that it meets approved letter #NRFE-O-327
8/2/62	330	Dissolved PWR (4) Fuel rods absorbed in vermiculate filled bottles	Y	Lead Cask	0.5	NL	120 mr/hr	120	U^{238} (532 gms) Pu^{239} (2.38 gms) U^{235} (1.77 gms)	Trench #26	Yes	Signed for S.S. accountability
8/3/62	331	(12) Solid PWR fuel rods contained in burial insert	Y	Lead Cask	0.5	NL	125 mr/hr	36	U^{238} (1596 gms) Pu^{239} (7.2 gms) U^{235} (5.3 gms)	Trench #26	Yes	Signed for S.S. accountability
10/24/62	365	Dissolved (5) PWR rod (Fuel) absorbed in Vermiculite filled bottles.	Y	Lead Cask	0.5	NL	150 mr/hr 50 mr/hr	150	U^{238} (665 gms) Pu^{239} (2.85 gms) U^{235} (2.2 gms)	Trench #27	Yes	Signed for S.S. accountability
11/29/62	382	Dissolved PWR Fuel Rods (5) absorbed in vermiculite filled poly bottles	Y	Lead Cask	0.5	NL	150 mr/hr 50 mr/hr	150	U^{238} (665 gms) Pu^{239} (2.85 gms) U^{235} (2.2 gms)	Trench #27	Yes	Signed for S.S. accountability
5/28/64	653	One 15 gallon drum spec. ICC-5c 304 containing 2.5 gallon dissolved SS material absorbed in vermiculite. PWR rod cooled > 120 days	Y		15 Gal. 3 ft^3	NL	100 mr/hr 5 mr/hr	60	U^{238} (268 gms) Pu^{239} (1.25 gms) U^{235} (0.18 gms)	Trench #34	Yes	Signed for S.S. accountability.
6/4/65	810	Irradiated core components, wear strips, end boxes, 12 PWR rods	Y	Cask	16 ft^3	NL	3 R/hr 400 mr/hr	13	U^{238} (1.59 Kg) Pu (0.5 gm)	Trench #36	Yes	Signed for S.S. accountability
6/26/67	67EWD150	20 Each Expended PWR Fuel Rods in a banded stainless Steel container	Y	Cask	16 cf	125	100 mr/hr 1 mr/hr	10	U^{238} (2,680 gm) Pu (15 gm)	Trench #45	Yes	Signed for S.S. Accountability
6/10/68	68EWD105	Scrap Insert #83 containing PWR Bundles #0291, and 0381 and misc. core hardware	Y	Cask	16 cf	26,000	125 mr/hr 15 mr/hr	900	U^{238} (31.68 Kg) U^{235} (80 gms) Pu (164 gm)	Trench #47	Yes	Signed for S.S. accountability

Date	Disposition Number	Description (as given on shipping record)	Fuel Mat'l (Y/N)	Container	Vol. (yd^3)	Wt. (lbs)	Radiation Levels[a]	Curies	Isotopes	Disposal Location	Hard Copy of Shipping Record?	Other
6/19/68	68EWD108	Scrap Insert #55 containing PWR Bundles #0750 and 0495 and misc core and loop hardware	Y	Cask	16 cf	26,000	150 mr/hr 40 mr/hr	110 (fuel)	U^{238} (31.68 Kg) U^{235} (80 gms) Pu (164 gm)	Trench #47	Yes	Signed for S.S. accountability
6/20/68	68EWD110	Scrap Insert #72 containing PWR Bundles #0044 and #0468 and S5W Misc. Hardware	Y	Cask	16 cf	26,000	5 R/hr 450 mr/hr	140 (fuel)	U^{238} (31.68 Kg) U^{235} (80 gms) Pu (164 gm)	Trench #47	Yes	Signed for S.S. accountability
6/24/68	68EWD117	Scrap Insert #88 containing 2 PWR bundles #0065 and 0504 and misc S5W hardware	Y	Cask	16 cf	26,000	4 R/hr 250 mr/hr	6,000 (total)	U^{238} (31.68 Kg) U^{235} (80 gms) Pu (164 gm)	Trench #47	Yes	Signed for S.S. accountability
6/25/68	68EWD118	Misc Hardware from S5W Disposal effort. Also two PWR rod bundles 0116 and 0144. Insert 74.	Y	Cask	16 cf	26,000	2 R/hr 200 mr/hr	85 (fuel)	U^{238} (31.68 Kg) U^{235} (80 gms) Pu (164 gm)	Trench #47	Yes	Signed for S.S. accountability
8/12/68	68EWD144	Scrap Insert #75 containing 2 PWR bundles #0320 and #0450	Y	Cask	16 cf	26,000	250 mr/hr 20 mr/hr	335	U^{238} (31.45 Kg) U^{235} (80 gms) Pu (160 gm)	Trench #48	Yes	Signed for S.S. accountability
8/14/68	68EWD147	72 each, PWR fuel rods and core hardware. Scrap Insert #66	Y	Cask	16 cf	26,000	50 mr/hr 1 mr/hr	24 (fuel)	U^{238} (10.33 Kg) U^{235} (10 gms) Pu (54 gm)	Trench #48	Yes	Signed for S.S. accountability

(a) The first reading is on contact while the second reading is at 1 meter.

Notes:

The following assumptions were made to sum the total isotopes disposed to the RWMC

- The 1/17/61 shipment did not include totals for U-238 and U-235. Using the same ratios of isotopes for a similar shipment on 11/22/60, 208 grams of U-238 and 0.92 grams of U-235 would have been disposed in this shipment.
- There are two separate burial records for 4/5/61. Both of them had 520 grams of "S.S." typed on the forms. Handwritten corrections to these forms appear to have assumed that there was a total of 520 grams between the two shipments and allocated 390 grams to one shipment and 130 grams to the other. Since the accountability "writeoff" letter indicates that 1.04 kg of uranium was written off for these shipments, the original higher typed values in the disposal records are considered to be correct. This table includes 520 grams for each of the two shipments.
- The 6/4/65 shipment did not have a total for U-235. Using the same ratios of isotopes as later shipments (6/67 through 8/68), approximately 4 grams of U-235 would have been disposed.
- The 6/26/67 shipment did not have a total for U-235. Using the same ratios of isotopes for later shipments (6/67 through 8/68), approximately 6.8 grams of U-235 would have been disposed.

Totals = 214 Kg U-238
639 grams U-235
1083 grams Pu-239

Total (Dissolved) = 5.48 Kg U-238
16.4 g U-235
22.1 g Pu-239

Total (Solid) = 208 Kg U-238
623 g U-235
1061 g Pu-239

Attachment 6

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SHIPPINGPORT CORE 1 SEED FUEL AND SOAP ASSEMBLIES TRANSFERRED TO OFF-SITE LOCATIONS OR IN ECF STORAGE

Shippingport Core 1 (PWR-1) seed fuel was primarily sent to the Idaho Chemical Processing Plant (ICPP) for reprocessing although small quantities were also sent to other facilities. Each seed assembly contained four subassemblies (S/A). Each subassembly contained 15 fuel elements. "Element" quantities refer to the total mass of uranium. "Isotope" quantities refer to total mass of Uranium-235. The serialized fuel accountability transfer transactions are referenced.

Date	Fuel Transferred	Quantity	Reference
6/3/60	Transfer of 15 element samples from PWR-1 Seed Assembly 1 to Bettis.	54g Element 44g Isotope	WEI-WEB-22
9/11/61	Transfer of 1 PWR-1 Seed 1 Assembly to ICPP.	1733g Element 1416g Isotope	WEI-CPI-78
9/18/61	Transfer of 1 PWR-1 Seed 1 Assembly to ICPP.	1733g Element 1416g Isotope	WEI-CPI-79
9/20/61	Transfer of 1 PWR-1 Seed 1 Assembly to ICPP.	1733g Element 1416g Isotope	WEI-CPI-80
9/25/61	Transfer of 1 PWR-1 Seed 1 Assembly to ICPP.	1733g Element 1416g Isotope	WEI-CPI-81
9/28/61	Transfer of 1 PWR-1 Seed 1 Assembly to ICPP.	1733g Element 1416g Isotope	WEI-CPI-82
9/11/61	Transfer of 1 PWR-1 Seed 1 Assembly to ICPP.	1733g Element 1416g Isotope	WEI-CPI-83
10/4/61	Transfer of 1 PWR-1 Seed 1 Assembly to ICPP.	1733g Element 1416g Isotope	WEI-CPI-84
10/5/61	Transfer of 1 PWR-1 Seed 1 Assembly to ICPP.	1733g Element 1416g Isotope	WEI-CPI-85
10/11/61	Transfer of 1 PWR-1 Seed 1 Assembly to ICPP.	1733g Element 1416g Isotope	WEI-CPI-86
10/20/61	Transfer of 1 PWR-1 Seed 1 Assembly to ICPP.	1733g Element 1416g Isotope	WEI-CPI-87
10/25/61	Transfer of 1 PWR-1 Seed 1 Assembly to ICPP.	1733g Element 1416g Isotope	WEI-CPI-88
10/26/61	Transfer of 1 PWR-1 Seed 1 Assembly to ICPP.	1733g Element 1416g Isotope	WEI-CPI-89
11/1/61	Transfer of 1 PWR-1 Seed 1 Assembly to ICPP.	1733g Element 1416g Isotope	WEI-CPI-90
11/2/61	Transfer of 1 PWR-1 Seed 1 Assembly to ICPP.	1733g Element 1416g Isotope	WEI-CPI-91
11/3/61	Transfer of 1 PWR-1 Seed 1 Assembly to ICPP.	1733g Element 1416g Isotope	WEI-CPI-92
11/7/61	Transfer of 1 PWR-1 Seed 1 Assembly to ICPP.	1733g Element 1416g Isotope	WEI-CPI-93
11/8/61	Transfer of 1 PWR-1 Seed 1 Assembly to ICPP.	1733g Element 1416g Isotope	WEI-CPI-94
11/9/61	Transfer of 1 PWR-1 Seed 1 Assembly to ICPP.	1733g Element 1416g Isotope	WEI-CPI-95
2/23/62	Transfer of 1 PWR-1 Seed 1 Assembly to ICPP.	1733g Element 1416g Isotope	WEI-CPI-100
2/23/62	Transfer of 1 PWR-1 Seed 1 Assembly to ICPP.	1733g Element 1416g Isotope	WEI-CPI-101
2/26/62	Transfer of 1 PWR-1 Seed 1 Assembly to ICPP	1733g Element 1416g Isotope	WEI-CPI-102

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2/27/62	Transfer of 1 PWR-1 Seed 1 Assembly to ICPP. 1733g Element 1416g Isotope	WEI-CPI-103
3/1/62	Transfer of 1 PWR-1 Seed 2 Assembly to ICPP. 1946g Element 1539g Isotope	WEI-CPI-104
3/2/62	Transfer of 1 PWR-1 Seed 1 Assembly to ICPP. 1733g Element 1416g Isotope	WEI-CPI-105
3/6/62	Transfer of 1 PWR-1 Seed 2 Assembly to ICPP. 1946g Element 1539g Isotope	WEI-CPI-106
3/7/62	Transfer of 1 PWR-1 Seed 2 Assembly to ICPP. 1946g Element 1539g Isotope	WEI-CPI-108
3/12/62	Transfer of 1 PWR-1 Seed 2 Assembly to ICPP. 1946g Element 1539g Isotope	WEI-CPI-110
3/19/62	Transfer of 1 PWR-1 Seed 2 Assembly to ICPP. 1946g Element 1539g Isotope	WEI-CPI-111
3/22/62	Transfer of 1 PWR-1 Seed 1 Assembly to ICPP. 1733g Element 1416g Isotope	WEI-CPI-113
5/29/62	Transfer of 1 PWR-1 Seed 2 Assembly to ICPP. 1946g Element 1539g Isotope	WEI-CPI-116
5/31/62	Transfer of 1 PWR-1 Seed 2 Assembly to ICPP. 1946g Element 1539g Isotope	WEI-CPI-117
6/4/62	Transfer of 1 PWR-1 Seed 2 Assembly to ICPP. 1946g Element 1539g Isotope	WEI-CPI-118
6/5/62	Transfer of 1 PWR-1 Seed 2 Assembly to ICPP. 1946g Element 1539g Isotope	WEI-CPI-119
6/7/62	Transfer of 1 PWR-1 Seed 2 Assembly to ICPP. 1946g Element 1539g Isotope	WEI-CPI-120
6/8/62	Transfer of 1 PWR-1 Seed 2 Assembly to ICPP. 1946g Element 1539g Isotope	WEI-CPI-121
7/3/62	Transfer of 1 PWR-1 Seed 2 Assembly to ICPP. 1946g Element 1539g Isotope	WEI-CPI-122
7/5/62	Transfer of 1 PWR-1 Seed 2 Assembly to ICPP. 1946g Element 1539g Isotope	WEI-CPI-123
7/5/62	Transfer of 1 PWR-1 Seed 2 Assembly to ICPP. 1946g Element 1539g Isotope	WEI-CPI-124
7/9/62	Transfer of 1 PWR-1 Seed 2 Assembly to ICPP. 1946g Element 1539g Isotope	WEI-CPI-125
7/11/62	Transfer of 1 PWR-1 Seed 2 Assembly to ICPP. 1946g Element 1539g Isotope	WEI-CPI-126
7/13/62	Transfer of 1 PWR-1 Seed 2 Assembly to ICPP. 1946g Element 1539g Isotope	WEI-CPI-127
7/26/62	Transfer of 1 PWR-1 Seed 2 Assembly to ICPP. 1946g Element 1539g Isotope	WEI-CPI-128
7/26/62	Transfer of 1 PWR-1 Seed 2 Assembly to ICPP. 1946g Element 1539g Isotope	WEI-CPI-129
8/1/62	Transfer of 1 PWR-1 Seed 2 Assembly to ICPP. 1946g Element 1539g Isotope	WEI-CPI-130
8/3/62	Transfer of 1 PWR-1 Seed 2 Assembly to ICPP. 1946g Element 1539g Isotope	WEI-CPI-131
8/7/62	Transfer of 1 PWR-1 Seed 2 Assembly to ICPP. 1946g Element 1539g Isotope	WEI-CPI-132
8/9/62	Transfer of 1 PWR-1 Seed 2 Assembly to ICPP. 1946g Element 1539g Isotope	WEI-CPI-133
8/10/62	Transfer of 1 PWR-1 Seed 2 Assembly to ICPP. 1946g Element 1539g Isotope	WEI-CPI-134
8/17/62	Transfer of 1 PWR-1 Seed 2 Assembly to ICPP. 1936g Element 1532g Isotope	WEI-CPI-138

1/30/63	Transfer of 1 PWR-1 Seed 1 Assembly to ICPP.	1732g Element 1416g Isotope	WEI-CPI-151
1/31/63	Transfer of 1 PWR-1 Seed 1 Assembly to ICPP.	1733g Element 1416g Isotope	WEI-CPI-154
2/4/63	Transfer of 4 PWR-1 Seed 1 S/As to ICPP.	1733g Element 1416g Isotope	WEI-CPI-158
2/8/63	Transfer of 4 PWR-1 Seed 1 S/As to ICPP.	1732g Element 1416g Isotope	WEI-CPI-161
2/11/63	Transfer of 3 PWR-1 Seed 1 S/As to ICPP.	1299g Element 1062g Isotope	WEI-CPI-165
3/25/63	Transfer of 4 PWR-1 Seed 2 S/As to ICPP.	1946g Element 1539g Isotope	WEI-CPI-188
3/26/63	Transfer of 4 PWR-1 Seed 2 S/As to ICPP.	1946g Element 1539g Isotope	WEI-CPI-191
3/26/63	Transfer of 2 PWR-1 Seed 2 S/As and 16 fuel elements to ICPP.	1431g Element 1131g Isotope	WEI-CPI-195
3/28/63	Transfer of 3 PWR-1 Seed 2 S/As to ICPP.	1459g Element 1154g Isotope	WEI-CPI-197
3/28/63	Transfer of 4 PWR-1 Seed 2 S/As to ICPP.	1946g Element 1539g Isotope	WEI-CPI-199
3/29/63	Transfer of 15 PWR-1 Seed 1 fuel elements and 1 PWR-1 Seed 2 fuel element to ICPP.	460g Element 376g Isotope	WEI-CPI-201
4/3/63	Transfer of 15 PWR-1 Seed 1 fuel elements to ICPP.	433g Element 354g Isotope	WEI-CPI-206
4/3/63	Transfer of 14 PWR-1 Seed 1 fuel elements to ICPP.	402g Element 330g Isotope	WEI-CPI-207
4/4/63	Transfer of 4 PWR-1 Seed 2 S/As to ICPP.	1946g Element 1539g Isotope	WEI-CPI-210
5/29/63	Transfer of 1 PWR-1 Seed 2 S/A to ICPP.	486g Element 385g Isotope	WEI-CPI-232
5/31/63	Transfer of 1 PWR-1 Seed 2 S/A to ICPP.	486g Element 385g Isotope	WEI-CPI-233
6/3/63	Transfer of 16 PWR-1 Seed 1 fuel elements to ICPP.	462g Element 378g Isotope	WEI-CPI-236
6/4/63	Transfer of 1 PWR-1 Seed 1 S/A and 12 fuel elements to ICPP.	780g Element 637g Isotope	WEI-CPI-237
6/10/63	Transfer of PWR-1 Seed section & fuel element to ICPP.	385g Element 314g Isotope	WEI-CPI-240
6/11/63	Transfer of 15 PWR-1 Seed 1 fuel elements to ICPP.	452g Element 372g Isotope	WEI-CPI-241
6/12/63	Transfer of 14 PWR-1 Seed 1 fuel elements to ICPP.	402g Element 330g Isotope	WEI-CPI-242
6/13/63	Transfer of 1 PWR-1 Seed 3 Assembly to ICPP	1988g Element 1482g Isotope	WEI-CPI-243
6/17/63	Transfer of 1 PWR-1 Seed 3 Assembly to ICPP.	1988g Element 1482g Isotope	WEI-CPI-244

6/18/63	Transfer of 1 PWR-1 Seed 3 Assembly to ICPP. 1988g Element 1482g Isotope	WEI-CPI-245
6/20/63	Transfer of 1 PWR-1 Seed 3 Assembly to ICPP. 1988g Element 1482g Isotope	WEI-CPI-247
6/21/63	Transfer of 1 PWR-1 Seed 3 Assembly to ICPP. 1988g Element 1482g Isotope	WEI-CPI-248
6/25/63	Transfer of 1 PWR-1 Seed 3 Assembly to ICPP. 1988g Element 1482g Isotope	WEI-CPI-249
6/27/63	Transfer of 1 PWR-1 Seed 3 Assembly to ICPP. 1988g Element 1482g Isotope	WEI-CPI-250
6/28/63	Transfer of 1 PWR-1 Seed 3 Assembly to ICPP. 1988g Element 1482g Isotope	WEI-CPI-252
7/1/63	Transfer of 1 PWR-1 Seed 3 Assembly to ICPP. 1988g Element 1482g Isotope	WEI-CPI-254
7/2/63	Transfer of 1 PWR-1 Seed 3 Assembly to ICPP. 1988g Element 1482g Isotope	WEI-CPI-255
7/3/63	Transfer of 1 PWR-1 Seed 3 Assembly to ICPP. 1988g Element 1482g Isotope	WEI-CPI-257
7/8/63	Transfer of 1 PWR-1 Seed 3 Assembly to ICPP. 1988g Element 1482g Isotope	WEI-CPI-259
7/8/63	Transfer of 1 PWR-1 Seed 3 Assembly to ICPP. 1988g Element 1482g Isotope	WEI-CPI-261
7/9/63	Transfer of PWR-1 Seed 1 elements to ICPP 95.86g Element 77.91g Isotope	WEI-CPI-251
7/9/63	Transfer of 1 PWR-1 Seed 3 Assembly to ICPP. 1988g Element 1482g Isotope	WEI-CPI-264
7/10/63	Transfer of 1 PWR-1 Seed 3 Assembly to ICPP. 1988g Element 1483g Isotope	WEI-CPI-265
7/12/63	Transfer of 1 PWR-1 Seed 3 Assembly to ICPP. 1988g Element 1483g Isotope	WEI-CPI-266
7/16/63	Transfer of 1 PWR-1 Seed 3 Assembly to ICPP. 1988g Element 1483g Isotope	WEI-CPI-267
7/19/63	Transfer of 1 PWR-1 Seed 3 Assembly to ICPP. 1988g Element 1483g Isotope	WEI-CPI-268
7/22/63	Transfer of 1 PWR-1 Seed 3 Assembly to ICPP. 1988g Element 1483g Isotope	WEI-CPI-269
7/23/63	Transfer of 1 PWR-1 Seed 3 Assembly to ICPP. 1988g Element 1483g Isotope	WEI-CPI-270
7/23/63	Transfer of 1 PWR-1 Seed 3 Assembly to ICPP. 1988g Element 1483g Isotope	WEI-CPI-271
8/8/63	Transfer of 1 PWR-1 Seed 3 Assembly to ICPP. 1988g Element 1482g Isotope	WEI-CPI-274
8/9/63	Transfer of 1 PWR-1 Seed 3 Assembly to ICPP. 1988g Element 1482g Isotope	WEI-CPI-275
8/12/63	Transfer of 1 PWR-1 Seed 3 Assembly to ICPP. 1988g Element 1482g Isotope	WEI-CPI-276
8/14/63	Transfer of 1 PWR-1 Seed 3 Assembly to ICPP. 1988g Element 1482g Isotope	WEI-CPI-277
2/3/64	Transfer of 1 PWR-1 Seed 3 Assembly to ICPP. 1988g Element 1482g Isotope	WEI-CPI-284
2/4/64	Transfer of 1 PWR-1 Seed 3 Assembly to ICPP. 1988g Element 1482g Isotope	WEI-CPI-285
2/5/64	Transfer of 1 PWR-1 Seed 3 Assembly to ICPP. 1988g Element 1482g Isotope	WEI-CPI-286
2/6/64	Transfer of 1 PWR-1 Seed 3 Assembly to ICPP. 1988g Element 1482g Isotope	WEI-CPI-288

2/7/64	Transfer of 1 PWR-1 Seed 3 S/A to ICPP.	497g Element 370g Isotope	WEI-CPI-289
8/28/64	Transfer of 3 PWR-1 Seed 3 S/As and 8 fuel elements to ICPP.	1725g Element 1286g Isotope	PZB-JZA-7
8/31/64	Transfer of 15 PWR-1 Seed 3 fuel elements to ICPP.	438g Element 327g Isotope	PZB-JZA-8
9/1/64	Transfer of 15 PWR-1 Seed 3 fuel elements to ICPP.	439g Element 326g Isotope	PZB-JZA-9
9/2/64	Transfer of 11 PWR-1 Seed 3 fuel elements to ICPP.	322g Element 239g Isotope	PZB-JZA-10
9/2/64	Transfer of 13 PWR-1 Seed 3 fuel elements to ICPP.	380g Element 283g Isotope	PZB-JZA-11
4/26/65	Transfer of 3 PWR-1 Seed 4 assemblies to ICPP.	6069g Element 4878g Isotope	PZB-JZA-39
4/30/65	Transfer of 4 PWR-1 Seed 4 S/As to ICPP	2023g Element 1626g Isotope	PZB-JZA-41
5/5/65	Transfer of 3 PWR-1 Seed 4 assemblies to ICPP.	6069g Element 4878g Isotope	PZB-JZA-42
5/20/65	Transfer of 3 PWR-1 Seed 4 assemblies to ICPP.	6069g Element 4878g Isotope	PZB-JZA-46
5/27/65	Transfer of 2 PWR-1 Seed 4 assemblies to ICPP.	4046g Element 3252g Isotope	PZB-JZA-49
6/14/65	Transfer of 2 PWR-1 Seed 4 assemblies to ICPP.	4046g Element 3252g Isotope	PZB-JZA-51
7/30/65	Transfer of PWR-1 Seed 3 elements to ICPP.	175g Element 131g Isotope	PZB-JZA-58
1/21/66	Transfer of PWR-1 SOAP element to ICPP.	0.114g Element 0.103g Isotope	PZB-JZA-79
1/27/66	Transfer of PWR-1 SOAP II fuel to ICPP.	.097g Element .082g Isotope	PZB-JZA-79
12/2/66	Transfer of 2 PWR-1 Seed 4 assemblies to ICPP.	4046g Element 3250g Isotope	PZB-JWA-13
12/9/66	Transfer of 4 PWR-1 Seed 4 assemblies to ICPP.	8092g Element 6500g Isotope	PZB-JWA-14
12/16/66	Transfer of 4 PWR-1 Seed 4 assemblies to ICPP.	8092g Element 6500g Isotope	PZB-JWA-15
12/30/66	Transfer of 3 PWR-1 Seed 4 assemblies to ICPP.	6069g Element 4875g Isotope	PZB-JWA-16
1/6/67	Transfer of 2 PWR-1 Seed 4 assemblies to ICPP.	4046g Element 3250g Isotope	PZB-JWA-17
6/9/67	Transfer of PWR-1 Seed 4 fuel to ICPP.	10g Element 8g Isotope	PZB-JWA-34

11/17/67	Transfer of PWR-1 Seed 4 fuel to ICPP.	19g Element 16g Isotope	PZB-JWA-56
7/31/69	Transfer of PWR-1 SOAP II Assy. To ICPP	486g Element 358g Isotope	PZB-JWA-91
10/31/69	Transfer of PWR-1 SOAP II Assy. To ICPP	487g Element 333g Isotope	PZB-JWA-94
11/30/69	Transfer of PWR-1 SOAP II To ICPP Transfer of PWR-1 SOAP I To ICPP	61g Element 52g Isotope 171g Element 103g Isotope	PZB-JWA-95
2/27/70	Transfer of PWR-1 SOAP To ICPP	320g Element 274g Isotope	PZB-JWA-99
5/28/71	Transfer of PWR-1 Seed 4 To ICPP	1g Element 1 g Isotope	PZB-JWA-116
7/6/71	Transfer of PWR-1 Seed 4 To ICPP	1g Element 1 g Isotope	PZB-JSA-1
7/13/71	Transfer of PWR-1 Seed 4 To ICPP	146g Element 117 g Isotope	PZB-JSA-1
1/24/72	Transfer of PWR-1 Seed 4 To ICPP	832.98g Element 669.50g Isotope	PZB-JSA-51
1/25/72	Transfer of PWR-1 Seed 1 S/A to ICPP	433g Element 354g Isotope	PZB-JSA-52
1/26/72	Transfer of PWR-1 Seed 1 S/A to ICPP Transfer of 2 PWR-1 Seed 4 S/As to ICPP	433g Element 354g Isotope 1011g Element 812.5g Isotope	PZB-JSA-53
1/27/72	Transfer of 2 PWR-1 Seed 4 S/As to ICPP	1011.5g Element 812.5g Isotope	PZB-JSA-54
1/31/72	Transfer of 2 PWR-1 Seed 4 S/As to ICPP	1011.5g Element 812.5g Isotope	PZB-JSA-56
2/1/72	Transfer of PWR-1 Seed 3 Assembly to ICPP	1988g Element 1482g Isotope	PZB-JSA-58
2/1/72	Transfer of PWR-1 Seed 2 Assembly to ICPP	1946g Element 1539g Isotope	PZB-JSA-59
8/17/90	Transfer of PWR-1 Seed 4 Assembly to ICPP	2023g Element 1626g Isotope	PZB-JXI-601
N/A	PWR-1 SOAP-I fuel in storage at ECF (from inventory reports): Enriched Uranium from PWR-1 SOAP-I	45g Element	27g Isotope
N/A	PWR-1 SOAP-2 fuel in storage at ECF (from inventory reports): Enriched Uranium from PWR-1 SOAP-II	52g Element	44g Isotope

Summary PWR-1 (Irradiated) Seed Fuel Transferred from NRF or in ECF Storage

Seed 1	26 Assemblies 13 S/As 74 Elements misc. elements	52,988 g Element 43,304 g Isotope
Seed 2	26 Assemblies 21 S/A	60,801 g Element 48,087 g Isotope
Seed 3	30 Assemblies 1 S/A 54 Elements misc. elements	61,891 g Element 46,143 g Isotope
Seed 4	29 Assemblies 10 S/As misc. elements	64,734 g Element 52,015 g Isotope
Combined Seed or Unspecified Seed	Misc. assemblies and elements	4,781 g Element 3,744 g Isotope
SOAP-I	Misc. fuel	216 g Element 130 g Isotope
SOAP-II	Misc. assemblies and fuel	1,086 g Element 787 g Isotope
Unspecified SOAP	Misc. fuel	320 g Element 274 g Isotope
Total		246,817 g Element 194,484 g Isotope

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Attachment 7

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SHIPPINGPORT CORE 1 BLANKET FUEL (NATURAL URANIUM) TRANSFERRED TO OFF-SITE LOCATIONS (OTHER THAN RWMC) OR IN ECF STORAGE

Shippingport Core 1 (PWR-1) blanket fuel (natural uranium) was primarily sent to the Hanford site for reprocessing. Some blanket fuel was sent to NRF for testing purposes or prior to being shipped to Hanford. In addition to the majority that was sent to Hanford, smaller quantities were sent to the Bettis-Pittsburgh and Oak Ridge National Laboratory. The PWR-1 contained 113 blanket subassemblies. Each subassembly contained 7 fuel bundles (total of 791). Each fuel bundle contained 120 fuel rods (total of 94,920). "Depleted" or "Normal U" typically refers to natural uranium. Serialized transfer transactions are given.

Date	Fuel Transferred	Quantity	Reference
2/19/60	Transfer of 2 rods from PWR blanket bundle #0551 to Bettis. (Values per DUQ-WEI-1)	.62 g Pu .24 Kg U .001 Kg U 235	WEI-WEB-16
4/15/60	Transfer of 2 rods from PWR blanket bundle #0551 to Bettis. (Values per DUQ-WEI-1)	.62 g Pu .26 Kg U .001 Kg U 235	WEI-WEB-19
5/22/61	Transfer of 3 rods from PWR fuel bundles to Knolls Atomic Power Laboratory.	1 g Pu .390 Kg U 2 g U 235	WEI-SGE-11
9/27/61	Transfer of rod #110 from PWR blanket bundle #035 to Bettis. (Values per DUQ-WEI-8)	.133 Kg U .0004 Kg U 235 .597g Pu	WEI-WEB-48
11/2/61	Transfer of rod #111 from PWR blanket bundle #0545 to Bettis. (Values per DUQ-WEI-8)	.133 Kg U .0004 Kg U 235 .597g Pu	WEI-WEB-52
12/8/61	Transfer of 2 rods from PWR blanket bundle #0485 Assy #035 to Bettis. (Values per DUQ-WEI-8)	.266 Kg U .0008 U 2351 .192 g Pu	WEI-WEB-55
5/25/62	Transfer of rod #23 from PWR blanket bundle #0671 Assy #047 to Bettis. (Values per DUQ-WEI-9)	.133 Kg U .442 g U 235 .596 g Pu	WEI-WEB-62
8/27/62	Transfer of 1 fuel rod from PWR blanket bundle 0558 to Bettis. (Values per DUQ-WEI-8)	.133 Kg U .442 g U 235 .596 g Pu	WEI-WEB-68
8/31/62	Transfer of 1 fuel rod from PWR blanket bundle 0558 to Bettis. (Values per DUQ-WEI-8)	.133 Kg U .442 g U 235 .596 g Pu	WEI-WEB-70
3/22/63	Transfer of 3 fuel rods from irradiated PWR blanket Assy. 041. (Per DUQ-WEI-14 values) to Bettis.	.3975 Kg U 1.2 g U 235 1.9 g Pu	WEI-WEB-83

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10/25/63	Transfer of 4 fuel rods from PWR Blanket Assy 041, Bundle 0079 to Bettis (As per values from DUQ-WEI-14).	.530 Kg U .0016 Kg U 235 2.5 g Pu	WEI-WEB-107CC2
11/19/63	Transfer of 6 PWR Rods from Assembly 50 (Shippers values per DUQ-WEI-17 and WEB-WEI- 114, 170, & 172) to Bettis.	.8 Kg U 2.4 g Pu	WEI-WEB-111CC1
3/20/64	Transfer of 2 PWR Rods containing depleted U and Pu (Rods 2,5 from Bundle 0386)	.3 Kg U U 235 (listed as negligible) 1 g Pu	WEI-WEB-118
5/25/64	Transfer of 2 fuel rods from LCSR "SABRE" Assembly to Bettis. (Rods 239 & 304) (Values as per DUQ-WEI-19CC)	3.632 Kg Depleted U .02 Kg U 235 8.6 g Pu	WEI-WEB-124
2/11/66	Transfer of 8 irradiated PWR-1 Blanket Subassembly Fuel Rods to Oak Ridge National Laboratory.	5 g Pu 1 Kg Depleted U .003 Kg U 235	PZB-FZC-1
2/18/66	Transfer of 2 PWR-1 Blanket Subassembly Rods to Bettis-Pgh.	1 g Pu .264 Kg U .001 Kg U235	PZB-PZA-49
3/11/66	Transfer of 2 PWR-1 Blanket Subassembly Rods to Bettis-Pgh.	1 g Pu .264 Kg U .001 Kg U235	PZB-PZA-5
4/22/66	Transfer of 54 irradiated PWR-1 Blanket Subassembly Rods to Bettis-Pgh.	37 g Pu 7 Kg U .02 Kg U235	PZB-PZA-54
6/22/66	Transfer of 14 irradiated PWR-1 Blanket Fuel Subassemblies to Isochem., Inc. in Richland, Wash. In container, M-130 #10.	8218 g Pu 1558 Kg Normal U 5 Kg U 235	PZB-HWA-1
8/1/66	Transfer of 16,288 irradiated PWR Core 1 Blanket Subassembly Fuel Rods to Isochem in M-130 #10.	10,382 g Pu 2,139 Kg Depleted U 7 Kg U 235	PZB-HWA-2
7/7/67	Transfer of 10 irradiated PWR-1 Blanket Subassembly Rods to Bettis-Pgh.	7 g Pu 1 Kg U U 235 (Listed as negligible)	PZB-PZA-76
10/27/67	Transfer of 8 irradiated PWR-1 Blanket Subassembly Rods to Bettis-Pgh.	6 g Pu 1 Kg U U 235 (Listed as negligible)	PZB-PZA-83
7/3/68	Transfer of 2 irradiated rods from the Sabre Test Assembly to Bettis-Pgh.	9 g Pu 3.64 Kg U U 235 (Listed as negligible)	PZB-PZA-101
10/3/69	Transfer of 29 irradiated PWR-1 Blanket Subassembly Rods to Bettis-Pgh.	9 g Pu 4 Kg U .02 Kg U235	PZB-PZA-83

2/14/74	Transfer of 47 PWR-1 Fuel Elements to Battelle, Pacific NW Laboratories.	32 g Pu 6 Kg U U 235 (Listed as negligible)	PZB-YDZ-1
7/7/78	Transfer of one PWR-1 blanket rod to Bettis-Pgh.	1 g Pu .13 Kg U U 235 (Listed as negligible)	PZB-PZA-216
7/7/80	Transfer of one 8-rod bundle section and one 7-rod bundle section of PWR-1 blanket fuel to Battelle Memorial, Columbus, Ohio	4 g Pu 2 Kg U U 235 (Listed as negligible)	PZB-CAF-74
9/16/87	Transfer of 1 PWR-1 rod and 44 rods from SABRE test assembly to ICPP	178 g Pu 80.06 Kg U	PZB-JXI-517

In Storage at ECF

Depleted Uranium Blanket Fuel	304Kg Element
Plutonium from PWR-1 Blanket Fuel	1,227g Plutonium

Summary Core 1 Blanket Fuel Transferred from NRF or in ECF Storage

Total PWR-1 blanket fuel transferred and in ECF Storage	4,114.8 Kg U 20.139 Kg Plutonium 12.1 Kg U-235[a]

(a) The total for U-235 is not likely to be accurate due to rounding and some transfers not including U-235 amounts. The reporting quantity for U-235 in Depleted Uranium is 1 Kg. As a result, values less than 0.5 Kg were not required to be listed.

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Attachment 8

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Curie Content of PWR-1 Blanket Fuel

Bettis-Pittsburgh personnel performed a detailed evaluation of existing information on the calculated and measured burnup and radionuclide content for PWR-1 blanket fuel. This core was designed by Bettis-Pittsburgh and analyzed analytically before operation. A key objective of the core examination program at ECF was to obtain data for comparison to calculations in order to assess the capability of analytical tools.

The parameters of most interest in the 1960's were burnup as well as uranium and plutonium concentrations. Therefore, the reports of the day deal almost exclusively with these parameters. In core examination programs, burnup was typically determined based on Cs-137 gamma measurements. Plutonium and uranium were determined based on dissolution of a relatively small number of blanket fuel rods. The large number of fission product and actinide radionuclides typically calculated today for environmental analyses were neither calculated nor measured by Bettis-Pittsburgh and ECF in the 1960's. Therefore, Bettis-Pittsburgh has performed new calculations using the Oak Ridge National Laboratory ORIGEN-S computer code.

Nearly all of the PWR-1 blanket fuel disposed of at RWMC was fuel that had been irradiated throughout all four seed lives. Therefore, Bettis-Pittsburgh focused on four seed life calculations. Thermal and fast neutron flux values from reference (a) were used as input along with time information for each seed operation. Each seed was treated as one time interval in a four time step calculation. ORIGEN-S provides output in both burnup (in MwD/Kg U) and radionuclide concentrations (in Ci/Kg U).

Bettis-Pittsburgh reports from the 1960's indicate that neutron fluxes, and therefore burnup, varied widely within the PWR-1 core blanket. Blanket fuel closest to the seed assemblies had higher neutron flux and higher burnup. The individual rods with the highest measured burnup were approximately 3 times higher than the blanket average burnup. Individual rod bundles could also have burnup approximately 2.5 times the blanket average. In addition to radial variation within the core, the burnup of blanket bundles would vary over the seven bundle height of individual blanket assemblies. Thus, determining the appropriate neutron flux for calculating the curie content of the fuel disposed of at RWMC was challenging.

Most of the fuel disposed of at RWMC consisted of intact bundles. The disposal records have bundle numbers for these intact bundles. Unfortunately specific subassembly locations have been found for only 3 of the 12 intact bundles. Of these three subassembly locations, two were adjacent to seed assemblies, and one was from the outer ring of the blanket. No height information has been located for any of the bundles. Thus, it is not possible at this time to determine how far the RWMC fuel may have differed from the blanket average. Therefore, the calculations focused on the blanket average. Given that the core examination program needed information from all parts of the blanket in order to calculate overall blanket performance, there is no reason to believe that the RWMC fuel systematically differed from the blanket average. Assigning curie content based on the highest blanket bundle burnup would clearly overestimate the curie content. A reasonable uncertainty for the RWMC fuel would be to assume that it could vary from the average burnup calculation by 50 percent based on this incomplete information on specific bundle location.

For the ORIGEN-S average burnup calculations, Bettis-Pittsburgh compared the calculated burnup with the average burnup reported in references (b) and (c). These results agreed within ten percent. In order to compare plutonium concentrations with plutonium measurements that

were made for rods with only one and two seed lives, Bettis-Pittsburgh performed some ORIGEN-S calculations for one and two seed lives. The ORIGEN-S calculated values for some plutonium isotopes were higher than the measured values by a factor of approximately three. Adjusting the flux information to force the ORIGEN-S calculated plutonium to match the measured plutonium resulted in burnup values that did not match the measured burnup information. Thus, it was not possible to get the ORIGEN-S program to adequately duplicate both the burnup and the plutonium. For these calculations, Bettis-Pittsburgh elected to slightly adjust the ORIGEN-S input parameters so that the calculated burnup closely matched the measured burnup and accept the fact that some isotopes of plutonium will be overestimated. Since the burnup information is based on number of fissions, this would indicate that other fission product concentrations should be reasonably accurate. Other actinide concentrations are likely to be high similar to the plutonium.

Interestingly, the 1960's Bettis-Pittsburgh reports generally reported good agreement between calculation and measurement, usually within 10 percent, for both burnup and plutonium concentrations. These calculations used detailed core modeling and Bettis-Pittsburgh computational methods of that era. A primary reason for the difference in results is due to the fact that ORIGEN-S treats the fast neutron spectrum with two energy groups rather than a large number of groups, as is usually done for core physics calculations. Even though new ORIGEN-S do not appear to be as accurate as the detailed core model burnup and plutonium calculations of the 1960's, it is necessary to use the new calculations to obtain the full range of radionuclides.

Radionuclide concentrations for various isotopes are presented in the following table. These values are for the average four seed burnup of 10.86 MwD/kg of natural uranium. Values for one year and five years after shutdown are provided. For fission product radionuclides, these values should be considered to have a potential uncertainty of 50% due to the uncertain core location of disposed fuel. Due to the known overcalculation of plutonium and actinides by a factor of approximately three, it would not be necessary or appropriate to increase the actinide values by any uncertainty factor.

Table 1. Activity concentrations for decayed fission products, actinides, and daughter products in the Shippingport natural uranium blanket elements based on 10.86 MwD/kg natural U.

Isotope	1 Years Decay Ci/kg	5 Years Decay Ci/kg
Ac-227	1.67E-10	4.47E-10
Am-241	1.04E-01	2.73E-01
Am-243	2.24E-04	2.24E-04
C-14	9.07E-05	9.07E-05
Cm-244	3.35E-03	2.87E-03
Cs-137	3.40E+01	3.08E+01
Eu-152	7.32E-03	5.94E-03
Eu-154	8.16E-01	5.92E-01
H-3	1.48E-01	1.18E-01
I-129	1.25E-05	1.25E-05
Nb-94	4.39E-08	4.39E-08
Np-237	2.55E-05	2.59E-05
Pa-231	2.32E-09	2.71E-09
Pb-210	1.65E-12	6.51E-12
Pu-238	1.14E-01	1.15E-01
Pu-239	4.25E-01	4.25E-01
Pu-240	3.71E-01	3.71E-01
Pu-241	2.91E+01	2.40E+01
Pu-242	2.45E-04	2.45E-04
Ra-226	2.49E-11	6.39E-11
Ra-228	2.10E-15	6.84E-15
Sr-90	1.99E+01	1.81E+01
Tc-99	4.78E-03	4.78E-03
Th-228	3.52E-07	8.68E-07
Th-229	6.03E-12	8.54E-12
Th-230	1.74E-08	2.77E-08
Th-232	9.36E-15	1.88E-14
U-232	7.56E-07	1.14E-06
U-233	6.90E-09	7.34E-09
U-234	2.79E-04	2.80E-04
U-235	4.53E-06	4.53E-06
U-236	4.81E-05	4.83E-05
U-238	3.29E-04	3.29E-04

References

a) WAPD-TM-265, Isotopic Analysis of Irradiated Natural Uranium Dioxide Fuel Rods from PWR Core 1, February 1962

b) WAPD-T-1608, Isotopic Composition of PWR Core 1 Blanket Irradiated to 16,000 MWD/Metric Ton U: Theory Vs Experiment, September 1963

c) WAPD-PWR-RD-1557, PWR-1 Component Examination Program, May 1963

10. NR:IBO-03/100—PRELIMINARY INFORMATION REQUESTED TO SUPPORT RWMC WASTE INVENTORY MODELING EFFORTS

Department of Energy
Pittsburgh Naval Reactors Office
Idaho Branch Office
P.O. Box 2469
Idaho Falls, Idaho 83403-2469

NR:IBO-03/100

September 2, 2003

J. G. Snook, Manager
Waste Area Group Seven
Idaho Operations Office, USDOE

SUBJECT: PRELIMINARY INFORMATION REQUESTED TO SUPPORT RWMC WASTE INVENTORY MODELING EFFORTS

References: 1) EM-ER-02-213 dated December 19, 2002 Request for Naval Reactors, Idaho Branch Office (NR/IBO) information regarding waste inventory shipped to the RWMC

2) NR:IBO-03/070 dated June 11, 2003 Forwarding of Preliminary Shippingport Fuel Review

NR/IBO is continuing to gather and analyze information requested by Reference (1). Based on our discussions of August 12, 2003, preliminary information is necessary by September 2, 2003 to support modeling efforts being performed by Bechtel BWXT Idaho. Information requested includes the following:

- Completing the remaining irradiated fuel assessments associated with the early cores for the S1W prototype and the USS Nautilus and potential disposal of irradiated fuel associated with test specimens.
- Assessment of the corrosion potential of irradiated metallic fines and chips (zirconium chips).
- Characterization of liquid-type waste forms.
- Assessment of the waste forms for technicium-99, iodine-129, carbon-14, and chlorine-36.

As stated during our recent discussions, this information which is presented in the attachment "RWMC Inventory Summary Information", is preliminary. Any adjustments to the attached information will be highlighted in the NR/IBO detailed assessment that will be provided at a latter date. NR/IBO recognizes that changes to the attached will be addressed qualitatively.

Again, it is our expectation that NR/IBO will review and concur on the use of its information prior to any release.

Please give me a call at 533-5294, if you have any questions.

W. R. Dixon
Naval Reactors Idaho Branch Office

cc: K. E. Hain, DOE-ID
J. K. Holdren, BBWI

J. G. Snook

NR:IBO-03/100
September 2, 2003

Attachment: RWMC Inventory Summary Information

bcc: M. Hutchison, NRF
J. Steele, NR-08R
W. R. Dixon, IBO

ATTACHMENT TO NR:IBO-03/100

RWMC Inventory Summary Information

Summary of Specific Radionuclides of Concern Associated with NRF Waste Streams

Waste Stream	Carbon-14 (in Curies)	Technicium-99 (in Curies)	Iodine-129 (in Curies)	Chlorine-36 (in Curies)
Shippingport Fuel (Solid) (1960-68)	1.89E-02	9.94E+00	2.60E-03	--
Shippingport Fuel (Dissolved) (1960-68)	4.99E-04	2.62E-01	6.86E-05	--
Miscellaneous Enriched Fuel (Solid) (1953-71)	2.34E-07	2.85E-02	4.94E-05	--
Miscellaneous Enriched Fuel (Dissolved) (1953-71)	1.49E-07	1.83E-02	3.16E-05	--
Miscellaneous Natural Fuel (Solid) (1953-71)	4.39E-04	2.31E-02	6.04E-05	--
Core Structural (1953-1997)	9.47E+01	5.19E-02	9.68E-05	4.05E-01
Zirconium Chips (1953-75)	3.28E+00	9.02E-05	1.73E-07	4.95E-03
Liquid/APAC/Oil (1953-71)	2.26E+00	9.89E-03	3.96E-05	--
Sludge/Resin (1953-1971)	3.87E+01	4.44E-02	1.78E-04	--
TOTAL	**1.39E+02**	**1.04E+01**	**3.12E-03**	**4.10E-01**

Irradiated Fuel Assessments

The Shippingport Fuel Review was provided in NR:IBO-03/070 dated June 11, 2003. A review of the early S1W and USS NAUTILUS cores has been completed. This review concludes that no significant quantity of S1W or USS NAUTILUS spent fuel was shipped to the RWMC. These early cores are essentially completely accounted for and no separate source term is warranted for them. With the exception of a few hundred grams of U-235, all the fuel is accounted for in fuel transaction and accountability records. The few hundred grams not specifically accounted for represents less than 0.5% of the amount of U-235 that was in the four early cores. This difference may be the result of rounding fuel weight to the nearest gram associated with the hundreds of transactions or possibly incomplete records for partial subdivided quantities of fuel sent to ICPP for reprocessing. A small amount of the fuel may have been destructively analyzed and sent to the RWMC in other NRF waste streams. These miscellaneous waste streams that may have contained small amounts of fuel were separately assessed and summarized below.

During the review of the Shippingport and S1W/NAUTILUS fuel, several sets of records were examined to look for other potential disposals of fuel material. Records reviewed included waste disposal records as well as fuel accountability and transfer records. This review found evidence that only very small amounts of nuclear material containing irradiated enriched uranium (U-235) were sent to the RWMC from NRF primarily during early operations until transuranic disposal controls were put in place around 1971. Disposal records in the 1960s typically indicated the amount of nuclear material associated with the shipment, if it was greater than accountability requirements (0.5 grams for U-235). Test specimens from test reactors were commonly received at NRF. These specimens were typically sent to ICPP for fuel reprocessing and do not provide a significant waste stream from NRF to the RWMC. Based on the disposal records that show only small amounts of nuclear material sent to the RWMC and accountability records that required accounting for fuel to very small amounts, it is concluded that only an estimated 205 grams of enriched U-235 was sent to the RWMC throughout NRF operations. Of this amount, an estimated 80 grams was associated with more mobile waste streams such as dissolved fuel or ion exchangers. There is a 20% uncertainty factor associated with the estimated fuel mass amounts. The curie distribution associated with the radionuclides of concern for this small amount of U-235 disposed to the RWMC is shown below and is estimated to have a plus or minus 50% uncertainty based on the uncertainty in the irradiation of this miscellaneous fuel.

Isotope	Curies (At One-Year Decay)
Ac-227	3.90E-09
Am-241	3,90E-03
Am-243	8.37E-05
C-14	3.87E-07
Cm-244	6.73E-03
Cs-137	3.41E+02
Eu-152	1.73E-02
Eu-154	1.89E+01
H-3	1.34E+00
I-129	8.10E-05
Nb-94	1.41E-07
Np-237	1.59E-03
Pa-231	1.01E-07
Pu-238	6.15E+00
Pu-239	1.27E-02
Pu-240	3.65E-03
Pu-241	1.87E+00
Pu-242	1.29E-05
Sr-90	3.38E+02
Tc-99	4.68E-02
Th-228	1.55E-05
Th-229	2.89E-10
Th-230	2.44E-07
U-232	5.56E-05
U-233	7.01E-07
U-234	1.15E-02
U-235	1.41E-04
U-236	1.44E-03
U-238	6.15E-07

In addition, to the Shippingport natural uranium (U-238) fuel known to have been disposed to the RWMC in the 1960s, an additional shipment of irradiated natural uranium fuel was disposed in 1968. This fuel was irradiated in a Naval core in one of the prototype plants. The total quantity of this one-time disposal was 4.845 kilograms (Kg) of U-238.. The curie content of this material is estimated by scaling from the Shippingport fuel using the respective weights of natural uranium. Thus the curie content of this additional amount of uranium would be 2.3% of the Shippingport curie content. The uncertainty of this estimate is considered to be plus or minus 50% based on the uncertainty in the irradiation of this particular material. Also, the review identified 33.893 kilograms of unirradiated natural uranium fuel that was disposed to the RWMC. This material was not irradiated, but was contaminated and therefore disposed at RWMC.

Corrosion Potential of Irradiated Metallic Fines and Chips (Zirconium Chips)

The corrosion rate information provided in NR:IBO-98/034 letter dated February 27, 1998, "Additional Information on Past and Projected Future Radioisotope Inventory From the Naval Reactors Facility and Comments on the Assumptions Used in the Radioactive Waste Management Complex Performance Assessment", should be used for this waste stream. Zirconium, like stainless steel, immediately forms a protective, invisible oxide film on its surface upon exposure to air. This oxide film is composed of zirconia (ZrO_2) and is on the order of only 50 to 100 angstroms in thickness. This ultra-thin oxide prevents the reaction of the underlying zirconium metal with virtually any chemical reagent under ambient conditions. The only reagent that will attack zirconium metal at room temperature is hydrofluoric acid (HF). HF will dissolve the thin oxide layer off of the surface of the metal and thus allow HF to dissolve the metal itself, with the concurrent evolution of hydrogen gas. However, it would require a fairly concentrated solution of HF to cause this attack, which is not typically found in significant concentrations in natural water sources.

The size of the zirconium chips can be used to determine a surface area-to-volume ratio. Disposal records indicated that the maximum size of the fines were 2 mils by 15 mils by 60 mils and the maximum size of the chips was 2 mils x 187 mils x 250 mils. The fines were estimated in the disposal records to make up 7% of the total zirconium chip weight.

A review of the zirconium chip waste stream from NRF to the RWMC was performed. Zirconium chips were disposed to the RWMC between 1956 and 1975. The following table shows the estimated amount of zirconium chips sent to the RWMC from NRF. The 13,550 pound estimate is considered accurate within plus or minus 50%.

Year	Shipments	Weight
1956	25	1200
1957	15	900
1958	2	120
1959	5	300
1960	3	180
1961	8	480
1962	4	240
1963	8	480
1964	5	300
1965	7	1200
1966	9	3500
1967	14	3500
1968	Unknown	125
1969	Unknown	125
1970	Unknown	275
1971	Unknown	125
1972	Unknown	125
1973	Unknown	125
1974	Unknown	125
1975	Unknown	125
Totals		**13,550**

The radionuclides contributing the largest curie amounts at the time of disposal are typically those associated with relatively short half-lives (such as cobalt-60, zirconium-95, etc). The following table provides the curie amounts for potential radioisotopes of concern associated with the zirconium chip waste stream based on an estimated weight of 13,550 pounds sent to the RWMC. The uncertainty associated with the curie calculations is estimated to be plus or minus 50%.

Isotope	Total Curies (@ 6 month decay)
H-3	6.70E+00
Ni-63	4.97E+00
C-14	3.28E+00
Cs-137	4.49E-01
Pu-241	3.13E-01
Sr-90	2.72E-01
Ni-59	3.93E-02
Pu-239	1.35E-02
Eu-154	6.57E-03
Cl-36	4.95E-03
Pu-240	4.72E-03
Nb-94	2.74E-03
Pu-238	2.37E-03
Am-241	1.78E-03
Eu-152	6.06E-04
U-232	1.67E-04
Th-228	1.17E-04
Tc-99	9.02E-05
U-233	8.79E-05
U-234	7.87E-06
U-238	7.07E-06
Cm-244	7.07E-06
Pa-231	4.44E-06
Np-237	1.16E-06
Pu-242	9.77E-07
Am-243	7.68E-07
Ac-227	6.58E-07
U-236	6.08E-07
K-40	3.18E-07
U-235	2.00E-07
I-129	1.73E-07
Th-232	1.33E-07

Characterization of Liquid Waste Streams

A review of NRF waste streams containing liquid/sludge/resin from 1953 to 1971 was performed. This represented the timeframe that the vast majority of free or stabilized liquid, sludge, or resin was discharged to the burial ground. The following table provides a volume summary of the waste sent to the RWMC.

Summary of Liquid/Sludge/Resin Disposal by Year from NRF to RWMC

Year	Liquid/slurry * (gallons)	Sludge (ft^3)	Resin (ft^3)	APAC (gallons)	Oil (gallons)	Misc. (gallons)
1954	-	-	7.5	-	-	-
1955	-	-	40	-	-	-
1956	-	-	20	-	-	-
1957	48,300	20	21	-	-	-
1958	38,700	-	41	-	-	-
1959	25,600	-	42	-	-	-
1960	6,000	372	52	-	55	-
1961	8,000	-	177	-	800	1,250**
1962	10,200	108	-	110	-	-
1963	12,000	72	130	5,115	2,950	-
1964	12,000	183	40	3,900	550	-
1965	-	191	260	385	1,830	-
1966	-	734	-	5,475	900	-
1967	-	614	-	-	1,225	-
1968	-	137	47	-	2,625	-
1969	-	1,435	-	-	2,000	-
1970	-	445	309	-	450	-
1971	-	464	382	2,700	665	-
Totals	160,800	4,775	1,568	17,685	14,050	1,250

APAC - alkaline permanganate ammonium citrate decontamination solution
*This included disposal that were primarily liquid with some diatomaceous earth or slurry-type material.
**This was a one-time shipment of 1,250 gallons of nitric acid to the RWMC acid pit.

Since most of the waste in these streams would be associated with radioactive crud from plant systems and naval cores, a generic crud profile was used to estimate the curies of radioisotopes present in the waste at the time of disposal. The generic crud profile allowed an estimate of the curies per gallon or curies per cubic foot. The curie estimates are considered conservative since the highest radiation readings observed in the shipping records were used for calculation purposes. The result of this evaluation was a total curie amount associated with a liquid/APAC/oil waste and total curie amount for the sludge/resin waste. This is shown below.

The uncertainty associated with these waste streams is large (estimated at 100%); however, because of the conservative nature of the evaluation, the curie amounts are considered a maximum amount. Carbon-14 (C-14) was not included in the generic crud profile, since it was evaluated as part of the 1998 assessment provided in NR:IBO-98/034 letter dated February 27, 1998. The assessment concluded that 41 curies of C-14 was sent to the RWMC from NRF in waste streams other than activated metal associated with core structural material. Assuming the entire 41 curies was only from the liquid/sludge/resin waste streams, which is a very conservative assumption, an estimated 2.26 curies of C-14 would be from the liquid waste stream and an estimated 38.7 curies of C-14 would be from the sludge/resin waste stream.

Liquid/APAC/Oil		Sludge/Resin	
Radioisotope	Curies	Radioisotope	Curies
Co-60	9.84E+02	Co-60	4.42E+03
Fe-55	1.96E+03	Fe-55	8.79E+03
Co-58	3.45E+03	Co-58	1.55E+04
Cr-51	1.74E+02	Cr-51	7.81E+02
Fe-59	1.99E+02	Fe-59	8.91E+02
Zr-95	8.49E+01	Zr-95	3.81E+02
Nb-95	1.87E+02	Nb-95	8.39E+02
Mn-54	9.59E+01	Mn-54	4.30E+02
Ni-63	2.97E+02	Ni-63	1.33E+03
Ni-59	2.97E+00	Ni-59	1.33E+01
Sb-125	9.79E+00	Sb-125	4.40E+01
Te-125m	2.25E+00	Te-125m	1.01E+01
Nb-93m	1.48E+01	Nb-93m	6.65E+01
Nb-94	1.98E-01	Nb-94	8.88E-01
Hf-181	7.86E+01	Hf-181	3.53E+02
Tc-99	9.89E-03	Tc-99	4.44E-02
Zn-65	4.75E+01	Zn-65	2.13E+02
Zr-93	1.98E-03	Zr-93	8.88E-03
Cs-134	1.95E-01	Cs-134	8.76E-01
Cs-137	3.95E-01	Cs-137	1.77E+00
Ba-137m	3.95E-01	Ba-137m	1.77E+00
Kr-85	1.97E-02	Kr-85	8.85E-02
Sr-90	3.95E-01	Sr-90	1.77E+00
Y-90	3.95E-01	Y-90	1.77E+00
I-129	3.96E-05	I-129	1.78E-04
Se-79	1.48E-06	Se-79	6.66E-06
Sn-126	4.45E-06	Sn-126	2.00E-05
Th-232	9.39E-10	Th-232	4.22E-09
U-232	1.48E-05	U-232	6.65E-05
Np-237	2.97E-08	Np-237	1.33E-07
Pu-238	2.47E-03	Pu-238	1.11E-02
Pu-239	3.96E-04	Pu-239	1.78E-03
Pu-240	2.47E-04	Pu-240	1.11E-03
Pu-241	9.87E-02	Pu-241	4.43E-01
Pu-242	2.97E-06	Pu-242	1.33E-05
Am-241	3.46E-03	Am-241	1.55E-02
Am-242m	1.98E-05	Am-242m	8.87E-05
Am-243	2.97E-05	Am-243	1.33E-04
Cm-242	6.05E-02	Cm-242	2.72E-01
Cm-243	2.47E-05	Cm-243	1.11E-04
Cm-244	3.46E-03	Cm-244	1.55E-02
Cm-245	2.47E-07	Cm-245	1.11E-06
Ru-106	9.54E-01	Ru-106	4.28E+00
Ce-144	9.08E-01	Ce-144	4.07E+00
Pm-147	3.03E-01	Pm-147	1.36E+00
U-233	2.67E-06	U-233	1.20E-05
U-234	2.97E-06	U-234	1.33E-05
U-235	2.08E-10	U-235	9.32E-10
U-236	1.09E-08	U-236	4.88E-08
U-238	4.85E-08	U-238	2.17E-07

Waste Forms of C-14, Tc-99, I-129, and Cl-36

NR:IBO-98/034 letter dated February 27, 1998 provided total curie amounts for technetium-99 (Tc-99), iodine-129 (I-129), and carbon-14 (C-14). These curie totals are applicable to the activated metal waste stream and, in the case of C-14, other waste streams associated with low-level waste generated from the prototypes and ECF. The waste form of Tc-99, I-129, and C-14 in the more mobile liquid/sludge/resin waste stream is provided in the discussion of C-14 and the table above. While NR:IBO-98/034 stated that the activated metal calculations were best estimate calculations, subsequent actual measurements showed these calculations to be conservatively high. In 2001, NRF contracted with ANL to measure the curie content of three actual pieces of irradiated structural material. This was done in order to compare the results with the calculated curie content. For the three items, the calculated curie content was higher than the measured amount by factors of approximately 3, 7, and 40. This effort demonstrated that the calculations performed for activated structural material are conservative and should be considered upper bound estimates.

Previously, a chlorine-36 (Cl-36) source term has not been calculated for Naval waste streams. Cl-36 is formed from activation of naturally occurring Cl-35. Chlorine is generally considered to be a detrimental material in reactor coolant systems and reactor structural material, and considerable measures are taken to keep chlorine out of both metals and reactor coolant systems. Thus, chlorine has generally been assumed not to be present in Naval materials. In view of the recent request to specifically consider Cl-36, a review was performed of structural material specifications and actual past measurements of chlorine content. While all of these past measurements have not indicated any measurable chlorine content in Naval materials, a calculation has been made for activated metals based on an assumed chlorine impurity of 1 part per million (ppm) in Naval structural materials. Using the same methods as the 1998 evaluation that included core power levels, various metals used in core construction, and the quantity of activated metal sent to the RWMC, Cl-36 was calculated for some types of materials and extrapolated for the rest of the activated metals sent to RWMC. The total estimated curie amount calculated for Cl-36 in activated metal is 0.41 curie. Due to the unmeasurable amount of chlorine in reactor coolant and crud, the presence of Cl-36 in the more mobile liquid/waste/resin waste form would be negligible. Since no actual chlorine has been measured in Naval materials, this should be considered an upper bound estimate.

11. NRFE-E-1448—CURIE CONTENT ESTIMATES FOR EXPENDED CORE FACILITY SCRAP CASKS

: KL/WURDJ. CUI IE CUILEIIL

FORM 73306A

NRFE-E-1448

1.

Westinghouse
Electric Corporation

Bettis Atomic Power Laboratory
Naval Reactors Facility
Box 2068
Idaho Falls Idaho 83403-2068

February 27, 1989

76-88

EG&G Idaho, Inc.
P.O. Box 1625
Idaho Falls, ID 83415-1625

Attention: J. N. Davis, Manager
RWMC/SWEPP Programs

Subject: Curie Content Estimates for ECF Scrap Casks

Gentlemen:

The Expended Core Facility's (ECF) internal audit program recently discovered that the method used for determining the curie content estimate for scrap cask inserts was in error. Several errors were noted, the cumulative effect of which was the significant underestimation of the curie values for all inserts shipped to the Radioactive Waste Management Complex since 1976.

Previous curie content estimates were determined by taking underwater radiation readings at several locations exterior to the insert. A model of the insert converted these radiation readings to curie content estimates taking in account geometry and self-shielding factors. Investigation of this method revealed that the model did not properly account for the self-shielding factors and did not account for several major isotopes having low energy radiation.

The method of calculating the curie content for the 55-ton scrap cask has been revised. The new technique is based on the radiation history of the individual components placed into the insert rather than any measurement of radiation. The technique is similar to the nuclear calculation methods used to predict power levels and lifetimes for nuclear cores and has been validated empirically.

ECF has reestimated the curie content of all radioactive waste insert shipments made to the Radioactive Waste Management Complex since 1976. The revised estimates correct the computational errors and account for the additional isotopes. These estimates are based on the number of cores received and processed at ECF during the time period in question, which is well known and documented data. The known modeling and isotopic omission errors were then factored into this data resulting in the revised per container estimate provided in Attachment I. This data is summarized on an annual basis in the following table:

OPTIONAL FORM 99 (7-90)

FAX TRANSMITTAL	# of pages ► 14
To Mike ABBott	From Rick Nieslanik
Dept./Agency	Phone # 3-5027
Fax # 6-0875	Fax # 3-5834

YEAR	ORIGINAL ESTIMATE	REVISED ESTIMATE	
OLD TYPE INSERTS			
1976	2,305	73,606.5	401,530.5
1977	4,526	144,530.5	
1978	1,097	35,030.9	
1979	3,418	109,148.3	
1980	1,228	39,214.2	
1981	603	19,255.8	
1982	221.2	7,063.7	
TOTAL	13,398.2	427,850.0	
55-TON CASK INSERTS			
1983	126.166	41,151	76-88
1984	150.171	341,998	
1985	189.766	141,740	
1986	47.450	35,919	
1987	39.688	29,643	
1988	37.385	6,729	
1989	.333	60	
TOTAL	590.959	597,241	

The approximate curie content, by percent, at the time of shipment is given below. The breakdown is provided for two distinct time periods based on the makeup of the material shipped.

ISOTOPE	1976-1980	1981-1989
Ni-63	2%	49%
Co-60	29%	32%
Fe-55	35%	16%
Co-58	--	3%
Sb-125	19%	--
Zr-95	10%	--
Sn-119	5%	--
TOTAL	100%	100%

Very truly yours,

2/27/89

J. A. Bartolomucci, Manager
ECF Engineering

Attachment

cc: T. M. Bradley [IBO-AB8]
T. L. Clements [PBF-632]
A. C. Davis [Bettis-02C]
R. D. Kaestner [ECF1]
W. D. Kimball [AB12]
D. R. Wilkinson [WMF-613]
NRF Central Files
/bls

REVISED CURIE ESTIMATE - SUMMARY BY YEAR

Shipment	Date Shipped	Orig. Est.	Rev. Est.
76-001-E	13-Jan-76	159.0	5077.4
76-010-E	12-Feb-76	16.0	510.9
76-011-E	16-Feb-76	159.0	5077.4
76-012-E	17-Feb-76	159.0	5077.4
76-013-E	18-Feb-76	239.0	7632.1
76-014-E	20-Feb-76	120.0	3832.0
76-018-E	04-Mar-76	22.0	702.5
76-020-E	09-Mar-76	10.0	319.3
76-044-E	01-Jul-76	120.0	3832.0
76-047-E	14-Jul-76	64.0	2043.7
76-049-E	20-Jul-76	6.0	191.6
76-050-E	22-Jul-76	9.0	287.4
76-051-E	23-Jul-76	8.0	255.5
76-053-E	27-Jul-76	159.0	5077.4
76-058-E	05-Aug-76	56.0	1788.3
76-062-E	17-Aug-76	13.0	415.1
76-063-E	19-Aug-76	40.0	1277.3
76-067-E	25-Aug-76	16.0	510.9
76-069-E	27-Aug-76	2.0	63.9
76-070-E	31-Aug-76	65.0	2075.7
76-073-E	08-Sep-76	32.0	1021.9
76-075-E	14-Sep-76	32.0	1021.9
76-076-E	16-Sep-76	4.0	127.7
76-078-E	23-Sep-76	5.0	159.7
76-079-E	27-Sep-76	4.0	127.7
76-083-E	05-Oct-76	3.0	95.8
76-085-E	11-Oct-76	159.0	5077.4
76-086-E	13-Oct-76	2.0	63.9
76-092-E	02-Nov-76	16.0	510.9
76-094-E	08-Nov-76	159.0	5077.4
76-097-E	22-Nov-76	119.0	3800.1
76-102-E	09-Dec-76	319.0	10186.8
76-104-E	17-Dec-76	2.0	63.9
76-105-E	21-Dec-76	7.0	223.5
1976 Total		2305.0	73606.5

Co-Co: (x .29 = 21,346)

REVISED CURIE ESTIMATE - SUMMARY BY YEAR

Shipment	Date Shipped	Orig. Est.	Rev. Est.
77-006-E	25-Jan-77	24.0	766.4
77-007-E	26-Jan-77	22.0	702.5
77-012-E	07-Feb-77	13.0	415.1
77-013-E	09-Feb-77	54.0	1724.4
77-018-E	15-Feb-77	239.0	7632.1
77-021-E	21-Feb-77	42.0	1341.2
77-022-E	22-Feb-77	15.0	479.0
77-023-E	23-Feb-77	65.0	2075.7
77-024-E	25-Feb-77	8.0	255.5
77-027-E	08-Mar-77	22.0	702.5
77-028-E	09-Mar-77	159.0	5077.4
77-030-E	14-Mar-77	32.0	1021.9
77-033-E	16-Mar-77	117.0	3736.2
77-036-E	17-Mar-77	159.0	5077.4
77-044-E	23-Mar-77	3.0	95.8
77-052-E	28-Mar-77	22.0	702.5
77-060-E	31-Mar-77	2.0	63.9
77-068-E	04-Apr-77	32.0	1021.9
77-077-E	07-Apr-77	22.0	702.5
77-080-E	14-Apr-77	22.0	702.5
77-084-E	21-Apr-77	43.0	1373.1
77-086-E	25-Apr-77	797.0	25450.9
77-087-E	27-Apr-77	1.0	31.9
77-088-E	28-Apr-77	2.0	63.9
77-089-E	03-May-77	22.0	702.5
77-091-E	11-May-77	38.0	1213.5
77-093-E	16-May-77	239.0	7632.1
77-094-E	19-May-77	3.0	95.8
77-097-E	24-May-77	16.0	510.9
77-101-E	07-Jun-77	200.0	6386.7
77-102-E	10-Jun-77	32.0	1021.9
77-105-E	17-Jun-77	159.0	5077.4
77-106-E	22-Jun-77	16.0	510.9
77-107-E	24-Jun-77	24.0	766.4
77-110-E	28-Jun-77	79.0	2522.7
77-113-E	07-Jul-77	6.0	191.6
77-114-E	11-Jul-77	11.0	351.3
77-115-E	14-Jul-77	14.0	447.1
77-116-E	18-Jul-77	43.0	1373.1
77-118-E	21-Jul-77	1.0	31.9
77-119-E	25-Jul-77	22.0	702.5
77-120-E	28-Jul-77	3.0	95.8
77-121-E	02-Aug-77	4.0	127.7
77-122-E	05-Aug-77	17.0	542.9
77-125-E	16-Aug-77	9.0	287.4
77-126-E	18-Aug-77	22.0	702.5
77-129-E	24-Aug-77	65.0	2075.7
77-132-E	26-Aug-77	6.0	191.6
77-135-E	08-Sep-77	87.0	2778.2
77-138-E	12-Sep-77	130.0	4151.3
77-139-E	14-Sep-77	359.0	11464.1

REVISED CURIE ESTIMATE - SUMMARY BY YEAR

Shipment	Date Shipped	Orig. Est.	Rev. Est.
77-140-E	19-Sep-77	319.0	10186.8
77-141-E	21-Sep-77	2.0	63.9
77-143-E	23-Sep-77	43.0	1373.1
77-148-E	18-Oct-77	160.0	5109.3
77-154-E	28-Oct-77	143.0	4566.5
77-158-E	04-Nov-77	32.0	1021.9
77-160-E	22-Nov-77	159.0	5077.4
77-161-E	28-Nov-77	97.0	3097.5
77-163-E	01-Dec-77	1.0	31.9
77-164-E	07-Dec-77	15.0	479.0
77-165-E	12-Dec-77	11.0	351.3
1977 Total		4526.0	144530.5
			Co-60: (x .29 = 41914)
78-013-E	03-Mar-78	2.0	63.9
78-021-E	17-May-78	6.0	191.6
78-023-E	23-May-78	11.0	351.3
78-025-E	30-May-78	4.0	127.7
78-026-E	31-May-78	1.0	31.9
78-028-E	01-Jun-78	1.0	31.9
78-031-E	05-Jun-78	54.0	1724.4
78-032-E	12-Jun-78	2.0	63.9
78-039-E	26-Jun-78	1.0	31.9
78-043-E	11-Jul-78	1.0	31.9
78-045-E	21-Jul-78	159.0	5077.4
78-046-E	25-Jul-78	5.0	159.7
78-048-E	31-Jul-78	128.0	4087.5
78-049-E	08-Aug-78	87.0	2778.2
78-051-E	10-Aug-78	80.0	2554.7
78-052-E	14-Aug-78	128.0	4087.5
78-058-E	08-Sep-78	65.0	2075.7
78-059-E	14-Sep-78	43.0	1373.1
78-061-E	21-Sep-78	108.0	3448.8
78-062-E	25-Sep-78	2.0	63.9
78-066-E	13-Oct-78	144.0	4598.4
78-075-E	26-Dec-78	65.0	2075.7
1978 Total		1097.0	35030.9
			Co-60: (x .29 = 10,159)

REVISED CURIE ESTIMATE - SUMMARY BY YEAR

Shipment	Date Shipped	Orig. Est.	Rev. Est.
79-004-E	03-Jan-79	96.0	3065.6
79-006-E	09-Jan-79	32.0	1021.9
79-008-E	17-Jan-79	2.0	63.9
79-015-E	13-Feb-79	159.0	5077.4
79-017-E	19-Feb-79	9.0	287.4
79-040-E	07-May-79	587.0	18744.9
79-043-E	16-May-79	6.0	191.6
79-046-E	30-May-79	6.0	191.6
79-047-E	06-Jun-79	59.0	1884.1
79-048-E	12-Jun-79	108.0	3448.8
79-049-E	15-Jun-79	18.0	574.8
79-051-E	18-Jun-79	86.0	2746.3
79-052-E	21-Jun-79	80.0	2554.7
79-053-E	26-Jun-79	319.0	10186.8
79-054-E	26-Jun-79	2.0	63.9
79-055-E	27-Jun-79	4.0	127.7
79-057-E	29-Jun-79	24.0	766.4
79-058-E	05-Jul-79	15.0	479.0
79-060-E	09-Jul-79	32.0	1021.9
79-061-E	12-Jul-79	478.0	15264.2
79-062-E	12-Jul-79	159.0	5077.4
79-063-E	16-Jul-79	2.0	63.9
79-064-E	17-Jul-79	191.0	6099.3
79-065-E	18-Jul-79	95.0	3033.7
79-066-E	18-Jul-79	207.0	6610.2
79-067-E	20-Jul-79	12.0	383.2
79-069-E	25-Jul-79	54.0	1724.4
79-070-E	26-Jul-79	9.0	287.4
79-071-E	27-Jul-79	9.0	287.4
79-074-E	31-Jul-79	108.0	3448.8
79-075-E	01-Aug-79	6.0	191.6
79-076-E	02-Aug-79	22.0	702.5
79-078-E	03-Aug-79	5.0	159.7
79-080-E	06-Aug-79	7.0	223.5
79-081-E	07-Aug-79	86.0	2746.3
79-084-E	09-Aug-79	7.0	223.5
79-086-E	14-Aug-79	111.0	3544.6
79-087-E	15-Aug-79	9.0	287.4
79-100-E	06-Sep-79	70.0	2235.3
79-128-E	04-Dec-79	11.0	351.3
79-134-E	13-Dec-79	32.0	1021.9
79-137-E	18-Dec-79	80.0	2554.7
79-143-E	27-Dec-79	4.0	127.7
1979 Total		3418.0	109148.3

60-60(x .29 = 31,653)

REVISED CURIE ESTIMATE - SUMMARY BY YEAR

Shipment	Date Shipped	Orig. Est.	Rev. Est.
80-002-E	03-Jan-80	104.0	3321.1
80-003-E	08-Jan-80	56.0	1788.3
80-005-E	14-Jan-80	65.0	2075.7
80-010-E	01-Feb-80	1.0	31.9
80-013-E	04-Mar-80	86.0	2746.3
80-017-E	21-Mar-80	7.0	223.5
80-018-E	31-Mar-80	96.0	3065.6
80-021-E	09-Apr-80	120.0	3832.0
80-022-E	15-Apr-80	88.0	2810.1
80-024-E	21-Apr-80	3.0	95.8
80-047-E	29-Oct-80	587.0	18744.9
80-052-E	17-Nov-80	13.0	415.1
80-060-E	23-Dec-80	2.0	63.9
1980 Total		1228.0	39214.2
			Co-60 (x .29 = 11,372)
81-003-E	22-Jan-81	4.0	127.7
81-006-E	29-Jan-81	64.0	2043.7
81-010-E	11-Feb-81	32.0	1021.9
81-012-E	14-Feb-81	80.0	2554.7
81-019-E	07-Apr-81	59.0	1884.1
81-022-E	09-Apr-81	3.0	95.8
81-028-E	30-Apr-81	79.0	2522.7
81-030-E	08-May-81	5.0	159.7
81-033-E	19-May-81	12.0	383.2
81-043-E	27-Jul-81	3.0	95.8
81-045-E	03-Aug-81	5.0	159.7
81-047-E	05-Aug-81	1.0	31.9
81-048-E	07-Aug-81	15.0	479.0
81-051-E	17-Aug-81	2.0	63.9
81-054-E	20-Aug-81	80.0	2554.7
81-055-E	24-Aug-81	5.0	159.7
81-057-E	16-Sep-81	80.0	2554.7
81-061-E	23-Sep-81	6.0	191.6
81-073-E	09-Nov-81	2.0	63.9
81-075-E	16-Nov-81	64.0	2043.7
81-077-E	01-Dec-81	2.0	63.9
1981 Total		603.0	19255.8
			Co-60 (x .32 = 6162)

REVISED CURIE ESTIMATE - SUMMARY BY YEAR

Shipment	Date Shipped	Orig. Est.	Rev. Est.
82-003-E	13-Jan-82	0.2	6.4
82-004-E	15-Jan-82	11.0	351.3
82-009-E	08-Feb-82	16.0	510.9
82-010-E	11-Feb-82	0.4	12.8
82-013-E	12-Mar-82	2.6	83.0
82-017-E	31-Mar-82	8.6	274.6
82-018-E	08-Apr-82	0.5	16.0
82-019-E	14-Apr-82	13.0	415.1
82-024-E	28-Apr-82	0.6	19.2
82-026-E	11-May-82	0.4	12.8
82-030-E	03-Jun-82	17.0	542.9
82-033-E	11-Jun-82	3.0	95.8
82-037-E	22-Jun-82	0.6	19.2
82-038-E	28-Jun-82	1.8	57.5
82-041-E	08-Jul-82	0.2	6.4
82-042-E	13-Jul-82	0.4	12.8
82-045-E	22-Jul-82	22.0	702.5
82-051-E	14-Aug-82	1.0	31.9
82-052-E	21-Aug-82	0.7	22.4
82-055-E	27-Aug-82	1.5	47.9
82-058-E	09-Sep-82	87.0	2778.2
82-062-E	30-Sep-82	6.5	207.6
82-068-E	18-Oct-82	1.5	47.9
82-070-E	25-Oct-82	2.9	92.6
82-073-E	29-Oct-82	2.2	70.3
82-075-E	04-Nov-82	0.2	6.4
82-077-E	09-Nov-82	9.7	309.8
82-078-E	15-Nov-82	6.7	214.0
82-079-E	16-Nov-82	1.5	47.9
82-081-E	30-Nov-82	1.5	47.9
1982 Total		221.2	7063.7

Co-60 (x.32 = 2260)

REVISED CURIE ESTIMATE - SUMMARY BY YEAR

Shipment	Date Shipped	Orig. Est.	Rev. Est.
110-8-81	15-Nov-82	6.7	2185
103-8-81	24-Mar-83	0.485	158
101-8-81	12-Apr-83	20.7	6752
102-6-82	27-Apr-83	8.845	2885
105-8-81	18-May-83	0.509	166
106-8-81	24-May-83	4.7	1533
108-8-81	25-Jul-83	8.9	2903
111-9-82	27-Jul-83	3.278	1069
107-8-81	22-Aug-83	1.049	342
119-9-82	11-Oct-83	71	23158
1983 Total		126.166	41151

Co-60: (X.32 = 13,168)

108-9-82	26-Jan-84	29.68	67593
112-9-82	01-Feb-84	0.37	843
116-9-82	13-Feb-84	11.16	25416
118-9-82	19-Feb-84	6.8	15486
06-83-104	09-Mar-84	6	13664
06-83-107	14-Mar-84	3.2	7288
105-6-82	13-Apr-84	4.622	10526
06-83-116	17-Apr-84	0.1	228
06-83-105	19-Apr-84	3.65	8312
06-83-108	24-Apr-84	3.81	8677
06-83-111	27-Apr-84	2.89	6582
120-9-82	02-May-84	4.18	9519
103-6-82	04-May-84	6.6	15031
110-9-82	21-May-84	3.7	8426
113-9-82	24-May-84	2.89	6582
06-83-112	30-May-84	3.1	7060
06-83-118	12-Jun-84	3	6832
06-83-101	28-Jun-84	3.52	8016
06-83-117	03-Jul-84	0.124	282
06-83-110	09-Jul-84	3.5	7971
06-83-114	13-Jul-84	5.8	13209
06-83-115	18-Jul-84	4.6	10476
06-83-109	24-Jul-84	3	6832
06-83-119	25-Aug-84	3.465	7891
06-83-113	31-Aug-84	4.89	11136
06-83-120	07-Sep-84	2.53	5762
03-84-110	14-Sep-84	5.19	11820
06-83-103	21-Sep-84	3.09	7037
03-84-104	01-Oct-84	4.18	9519
03-84-107	07-Oct-84	3.66	8335
03-84-103	31-Oct-84	3.78	8609
03-84-106	21-Dec-84	3.09	7037
1984 Total		150.171	341998

Co-60: (X.32 = 109,439)

REVISED CURIE ESTIMATE - SUMMARY BY YEAR

Shipment	Date Shipped	Orig. Est.	Rev. Est.
104-8-81	10-Jan-85	4.788	3576
03-84-109	23-Jan-85	2.98	2226
03-84-120	14-Feb-85	4.21	3145
115-9-82	28-Feb-85	4.832	3609
03-84-118	12-Mar-85	6.07	4534
03-84-119	07-May-85	7.63	5699
06-83-106	10-May-85	8.86	6618
03-84-117	20-May-85	7.47	5579
03-84-115	23-May-85	8.42	6289
03-84-116	28-May-85	7.71	5759
03-84-102	31-May-85	5.22	3899
03-84-108	05-Jun-85	4.7	3511
06-83-102	10-Jun-85	7.68	5736
03-84-113	14-Jun-85	7.87	5878
04-85-131	18-Jun-85	7.549	5639
04-85-110	20-Jun-85	5.86	4377
03-84-112	25-Jun-85	6.45	4818
04-85-102	28-Jun-85	5.97	4459
102-9-82	03-Jul-85	5.16	3854
03-84-101	09-Jul-85	6.7	5004
104-6-82	23-Jul-85	6.57	4907
04-85-139	26-Jul-85	9.42	7036
04-85-137	30-Jul-85	14.61	10913
04-85-140	13-Aug-85	4.67	3488
04-85-138	19-Sep-85	5.01	3742
106-9-82	21-Oct-85	5.2	3884
04-85-127	25-Oct-85	3.45	2577
03-84-111	04-Nov-85	3.213	2400
04-85-136	07-Nov-85	4.74	3540
04-85-107	21-Nov-85	2.36	1763
04-85-135	27-Nov-85	0.61	456
04-85-118	12-Dec-85	0.214	160
04-85-128	20-Dec-85	2.94	2196
04-85-126	27-Dec-85	0.63	471
1985 Total		189.766	141740

Co-60: (X.32 = 45,357)

REVISED CURIE ESTIMATE - SUMMARY BY YEAR

Shipment	Date Shipped	Orig. Est.	Rev. Est.
109-9-82	15-Jan-86	0.64	478
04-85-122	21-Jan-86	3.12	2330
04-85-121	24-Jan-86	0.314	235
04-85-130	29-Jan-86	0.889	664
04-85-125	06-Feb-86	0.132	99
04-85-133	11-Feb-86	3.36	2510
04-85-134	19-Feb-86	0.083	62
04-85-132	22-Apr-86	2.83	2114
04-85-120	30-Apr-86	1.077	804
04-85-124	06-May-86	0.524	391
04-85-123	27-May-86	10.54	7873
04-85-104	30-Jul-86	0.422	315
11-85-114	14-Aug-86	2.24	1673
11-85-120	26-Sep-86	8.75	6536
04-85-119	21-Oct-86	0.613	458
11-85-108	24-Oct-86	1.734	1295
04-85-117	30-Oct-86	0.582	435
11-85-115	06-Nov-86	3.257	2433
11-85-112	12-Nov-86	0.56	418
11-85-103	09-Dec-86	1.52	1135
11-85-109	12-Dec-86	3.484	2602
04-85-109	19-Dec-86	1.419	1060
1986 Total		47.45	35919

Co-Co: (X .32 = 11,494)

REVISED CURIE ESTIMATE - SUMMARY BY YEAR

Shipment	Date Shipped	Orig. Est.	Rev. Est.
11-85-106	09-Jan-87	0.763	570
04-85-105	15-Jan-87	0.293	219
04-85-129	21-Jan-87	1.39	1038
04-85-101	22-Jan-87	1.208	902
11-85-102	28-Jan-87	3.674	2744
11-85-115	30-Jan-87	0.76	568
04-85-111	09-Feb-87	0.288	215
11-85-101	12-Feb-87	0.63	471
11-85-105	24-Feb-87	1.417	1058
11-85-104	02-Mar-87	1.549	1157
11-85-117	09-Mar-87	0.4078	305
03-84-114	12-Mar-87	0.1438	107
11-85-111	18-Mar-87	0.71	530
11-85-113	24-Mar-87	1.434	1071
07-86-109	27-Mar-87	1.445	1079
11-85-119	31-Mar-87	3.625	2708
11-85-118	27-Jun-87	0.893	667
07-86-112	08-Jul-87	1.839	1374
07-86-103	10-Aug-87	2.653	1982
07-86-105	26-Aug-87	1.313	981
07-86-115	02-Sep-87	0.945	706
04-85-103	11-Sep-87	1.078	805
07-86-102	21-Sep-87	1.428	1067
117-9-82	13-Oct-87	0.525	392
07-86-118	10-Nov-87	1.141	852
07-86-119	13-Nov-87	0.776	580
07-86-104	23-Nov-87	0.405	303
04-85-108	01-Dec-87	1.2	896
07-86-107	04-Dec-87	5.7	4257
04-85-113	23-Dec-87	0.054	40
	1987 Total	39.6876	29643

Co-60: (x.32 = 9486)

REVISED CURIE ESTIMATE - SUMMARY BY YEAR

Shipment	Date Shipped	Orig. Est.	Rev. Est.
07-86-117	11-Jan-88	2	360
07-86-111	20-Jan-88	1.178	212
07-86-106	03-Feb-88	3.69	664
07-86-101	08-Feb-88	1.234	222
04-85-112	10-Feb-88	0.828	149
07-86-120	12-Feb-88	3.47	625
07-86-116	22-Feb-88	2.22	400
07-86-108	26-Feb-88	3.96	713
04-85-114	08-Mar-88	0.03	5
09-87-104	13-Jul-88	1.28	230
09-87-117	01-Aug-88	0.422	76
09-87-116	08-Aug-88	2.233	402
11-85-107	12-Sep-88	0.895	161
09-87-111	29-Nov-88	2.782	501
07-86-113	02-Dec-88	0.021	4
09-87-103	20-Dec-88	11.142	2005
1988 Total		37.385	6729
09-87-123	03-Jan-89	0.333	60
1989 Total		0.333	60

12. AMJ-77-95—EVALUATION OF MATERIAL AT RWMC PREVIOUSLY IDENTIFIED AS SPENT NUCLEAR FUEL

Idaho National Engineering Laboratory

July 14, 1995

Mr. P. J. Dirkmaat
National Spent Nuclear Fuel Program
U. S. Department of Energy
Idaho Field Office
850 Energy Drive, MS-1154
Idaho Falls, ID 83401-1563

Re: Evaluation of Material at RWMC Previously Identified as Spent Nuclear Fuel - **AMJ-77-95**

Dear Mr. Dirkmaat:

Per your request, we have conducted an evaluation of potential spent nuclear fuel (SNF) located at the Sub-surface Disposal Area of the Radioactive Waste Management Complex (RWMC).

Attached is a report of a limited search that was made of the Radioactive Waste Management Information System (RWMIS) database and the shipping manifests of material sent to the RWMC prior to 1970. Of the 110 records identified in RWMIS as "fuel rods" or "irradiated material," 56 have the characteristics of SNF containing a total of 124.64 kg of uranium. The attached report indicates, as also acknowledged in the RWMIS disclaimer, that there are several coding problems and other errors in the RWMIS database. The search reported here was not an exhaustive search of all the shipping manifests and there is potentially additional material at the RWMC having SNF characteristics. The research on questionable material used report EGG-WM-10903, "A Comprehensive Inventory of Radiological and Non-Radiological Contaminants Buried in the Sub-Surface Disposal Area of the INEL RWMC during the years 1952 - 1982," dated June 1994.

There are also located at the RWMC, 23 uranium bricks that were used as the outer blanket for the EBR-1 reactor. This material apparently has had very low exposure to a neutron flux so it does not meet the present definition of SNF. Because the material is already being managed under CERCLA and it does not meet the present definition of SNF, Lockheed recommends that it continue to be managed under CERCLA in a manner consistent with present law. If the definition of SNF changes this issue may have to be readdressed.

Lockheed Idaho Technologies Company P. O. Box 1625 Idaho Falls, ID 83415

The attached report has been reviewed by LMIT technical and management personnel from both the SNF and Environmental Restoration programs who have concurred with the conclusions.

Sincerely,

A. M. Jensen, Director
National Spent Nuclear Fuel
and Related Programs

DLF/idh

Attachment

EVALUATION OF MATERIAL AT RWMC PREVIOUSLY IDENTIFIED AS SPENT NUCLEAR FUEL

A search of the Radioactive Waste Management Information System (RWMIS) was conducted, using the key words "Irradiated fuel" and "Fuel Rods" (schedule # P61PM090; dated 06/19/95). Records of 110 shipments to the Radioactive Waste Management Complex (RWMC) Subsurface Disposal Area (SDA) included these descriptor. Shipping manifests of 95 of these records were found and evaluated. An evaluation of the shipping manifests that were available and the RWMIS information where the shipping manifests were not available was conducted. A table, identifying the 110 RWMIS records selected, is attached.

The information contained on the shipping manifests and RWMIS printout was reviewed, using the following criteria:

1. Uranium and/or plutonium was mentioned in the contents.
2. Contents appeared to have been irradiated in a reactor, based on radiation levels or Curie content.
3. Descriptions indicated that the materials could have come originally from SNF.

These criteria are similar to the definition of spent nuclear fuel (SNF) used in the Programmatic and INEL SNF EIS.

The results of this review showed that only 56 of the 110 shipments actually included material that could be classified as SNF. Forty four of the shipments cannot be classified as containing SNF by the review criteria listed above, and appear to have been miscoded. A spot check of the data contained in the RWMIS printout against the shipping manifests also showed that the information in RWMIS contains errors, as acknowledged in a disclaimer on the RWMIS printout. In one case the uranium mass in the RWMIS data base was ten times greater than that on the corresponding shipping manifest (shipping manifest # 800 250 20; dated 8/12/68).

The type of wastes classified in this review as containing SNF includes:

analytical sample waste,
partial SNF plates,
fuel pellets,
uranium oxide powder,
reactor experiments,
dissolved fuel rods solidified with vermiculite, and
PWR rod bundles

Much of this material was packaged with non-SNF materials, such as shielding, plastics, paper, irradiated metals, and other waste debris. The total weight in many cases also included the weight of the container. The total mass of uranium in the 56 shipping manifests classified as containing SNF materials was 124.64 kg.

One shipment (shipping manifest #800 1000 300 (15)) was identified that contained 887.8 kg of natural uranium. This was identified as 23 EBR-1 blanket bricks, 21 of which are contained in stainless steel. Core descriptive material indicates that this material was part of the outer blanket. The blanket contains a calculated 10.5 g of plutonium, or only 11 part per million. This indicates a very low exposure to neutron flux. Data input for the Historical Data Task for RWMC SDA has classified the material as low level waste containing no fission products. This evaluation also concluded that the blanket material is not spent fuel. The basis for the conclusion include: 1) it meets the 5280.2a definition of low level waste, 2) it had very low exposure to a neutron flux, and 3) in comparison to other blanket materials that are classified as spent nuclear fuel it has very low radioactivity and actinide content. FERMI blanket (uranium metal stainless steel clad) is classified as SNF because it has 0.35% burnup and 191 ppm plutonium. The EBR-1 outer blanket is significantly less than FERMI blanket. This entry (#3) was marked as non-SNF in the table.

EVALUATION OF MATERIAL LOCATED IN RWMC
CODED IN RWMIS AS FUEL ROD OR IRRADIATED MATERIAL

ITEM	TRENCH	GENERATOR	SM #	SNF	NON SNF	PLACEMENT DATE	URANIUM MASS (Kg)	COMMENTS
1	32	ANL601	800 50 0		x	5/15/63		Spent resin
2	34	ANL601	8 750 2	x		4/24/64	0.001	Uranium foil
3	39	ANL601	800 1000 300 (15)		x[1]	9/15/65		EBR-1 outer blanket
4	43	ANL767	830 ?? (80) 5	x		4/20/67	0.0078	Analytical waste
5	45	ANL767	810 8 0	x		7/20/67	18.486	Hot cell waste
6	47	ANL767	820 2 0	x		7/1/68	9.267	Hot cell waste
7	47	ANL767	830 3 0	x		7/1/68	9.257	Hot cell waste
8	48	ANL767	820 0000	x		10/17/68	0.0186	Analytical waste
9	48	ANL767	830 0000	x		10/17/68	0.0157	Analytical waste
10	48	ANL767	800 50 5	x		10/22/68	0.0022	Analytical waste
11	48	ANL767	810 50 5	x		10/22/68	0.0035	Analytical waste
12	48	ANL767	800 0000	x		11/7/68	0.0175	Analytical waste
13	48	ANL767	810 0000		x	11/7/68		Cold line waste
14	48	ANL767	820 65 5	x		12/9/68	0.0105	Analytical waste
15	31	ARA602	810 275 30	x		10/10/63	0.018	Hot cell waste
16	33	CPP601	8 175 20	x		1/31/64	none	"Containing Pu"
17	17	NRF618	800 1000 100		x	1/28/60		Fission products; no uranium
18*	16	NRF618	810 10 1		x	1/29/60		Co-60
19*	16	NRF618	820 40 10		x	1/29/60		Co-60
20	17	NRF618	800 350 30		x	3/17/60		Nonfuel components
21*	3	NRF618	2 2 1		x	2/11/64		Co-60
22	45	NRF618	800 2800 250		x	3/2/67		Spent resin
23	43	NRF618	810 50 2		x	5/17/67		Spent resin
24	48	NRF618	800 250 20	x		8/12/68	31.53	2 PWR bundles
25	25	OFFGDA	810 960009999		x	8/14/61		Nonfuel components

ITEM	TRENCH	GENERATOR	SM #	SNF	NON SNF	PLACEMENT DATE	URANIUM MASS (Kg)	COMMENTS
26	25	OFFGDA	810 999999999		x	9/29/61		Nonfuel components
27	25	OFFGDA	810 999999999		x	11/9/61		Nonfuel components
28	27	OFFGDA	800 750 ?? (40)		x	11/19/62		Nonfuel components
29	28	OFFGDA	800 700000		x	12/26/62		Nonfuel components
30*	CF608U NKN	OFFGDA	800 999999999	x		5/10/66	0.0768	Spent fuel
31*	CF608U NKN	OFFGDA	810 999999999	x		5/13/66	0.0551	Spent fuel
32	20	OFFGEC	800 500005556		x	6/7/61		Nonfuel components
33	41	PER601	2 600 35	x		2/3/66	0.0245	UO_2 waste residue
34	42	PER601	2 1000 30	x		9/30/66	0.0485	Fuel rod pieces
35	42	PER601	2 800 20	x		10/18/66	0.485	Fuel rod pieces
36	26	TAN607	800 5000 ?? (0)		x	7/5/62		Analytical waste
37*	UNKN UNKN	TAN607	800 60 6		x	2/5/65		Unknown - no U, AP, or FP
38*	UNKN UNKN	TAN633	800 40 4		x	2/5/65		Unknown - no U, AP, or FP
39	40	TAN633	800 0000		x	12/21/65		Hot cell waste
40	17	TRA603	820 35		x	4/1/60		Nonfuel components
41	30	TRA603	800 2 0	x		6/27/63	0.141	U-carbide experimental waste
42	35	TRA603	2 200 10	x		9/15/64	0.0028	U-Zr eperimental waste
43	41	TRA603	1 30 5	x		3/4/66	0.199	Al-clad capsule
44	27	TRA632	800 4500 500		x	9/13/62		Filter media
45	31	TRA632	800 500 50	x		9/26/63	<0.1	Fuel plate
46*	CF606U NKN	TRA632	1 90 16		x	5/25/66		Unknown - No U
47	42	TRA632	1848 90 16	x		5/25/66	0.008	Fuel plate
48	43	TRA632	1 1 0	x		11/21/66	0.1	Hot cell waste

ITEM	TRENCH	GENERATOR	SM #	SNF	NON SNF	PLACEMENT DATE	URANIUM MASS (Kg)	COMMENTS
49	19	TRA642	800 ?? (600R 72R)		x	11/21/60		Hot cell waste - No U
50	19	TRA642	810 ?? (864R 96R)		x	11/22/60		Nonfuel components
51	25	TRA642	800 ?? (1495 167)		x	1/18/62		Nonfuel components
52	34	TRA642	3 1000 30		x	6/23/64		Fission prod. - no U
53*	CF608U NKN	TRA642	810 240 30	x		10/19/65	0.029	Unknown - contains U-235
54*	CF606U NKN	TRA642	4 6 0		x	4/5/66		Unknown - no U
55	30	ANL601	800 1000 50		x	6/26/63		Flow rod Al & SS
56	32	ANL601	800 7000 250		x	8/7/63		Fuel rod handles
57	30	ANL601	800 1000 250		x	8/20/63		Fuel rod handles
58	32	ANL601	800 4500 500		x	8/30/63		Fuel rod handles
59	32	ANL601	800 7500 900		x	9/6/63		Fuel rod handles
60	47	ANL720	800 2000 20	x		5/13/68	0.200	TREAT fuel rod
61	46	ANL767	800 130 4	x		1/11/68	0.200	Blanket rod samples
62	46	ANL767	800 50 10	x		1/17/68	0.07	Dissolved fuel rods in vermiculite
63	48	ANL767	810 1 1	x		1/11/68	0.55	Melted fuel pins
64	48	ANL767	820 100 1	x		11/11/68	0.07	Epoxied fuel rod
65	48	ANL767	800 60 5	x		1/13/69	0.02	U-F alloy samples
66	48	ANL767	810 60 5	x		1/13/69	0.12	Dissolved fuel samples in vermic.
67	50	ANL767	830 1 0		x	9/15/69		3 kg U probably unirr.; low rad. & low Ci listed
68	43	CPP601	800 25 1		x	3/15/67		Fuel element end pieces
69	44	NRF601	800 10 1		x	1/12/67		Nonfuel components
70	P10	NRF601	830 50 1	x		3/20/70	0.06	Pu-239 12g, Np-237 1g
71	20	NRF618	800 70 6	x		4/12/61	0.13	Dissolved rods in vermiculite
72	20	NRF618	810 70 6	x		4/18/61	0.39	Dissolved rods in vermiculite
73	26	NRF618	820 100 10	x		5/8/62	0.40	Dissolved rods in vermiculite

ITEM	TRENCH	GENERATOR	SM #	SNF	NON SNF	PLACEMENT DATE	URANIUM MASS (Kg)	COMMENTS
74	26	NRF618	820 250 25	x		7/10/62	0.67	Dissolved rods in vermiculite
75	26	NRF618	800 120 13	x		8/6/62	0.53	Dissolved rods in vermiculite
76	26	NRF618	810 125 13	x		8/7/62	1.60	PWR rods
77	27	NRF618	800 150 50	x		10/30/62	0.67	Dissolved rods in vermiculite
78	27	NRF618	800 150 50	x		12/4/62	0.67	Dissolved rod in vermiculite
79	33	NRF618	800 5 0	x		10/11/63	14.68	109 fuel rod pieces
80*	CF608U NKN	NRF618	800 500 40		x	4/28/65		Unknown - no U
81	43	NRF618	830 120 5		x	4/12/67		Control rod end pieces
82	43	NRF618	810 70 18		x	4/20/67		Control rod section
83	45	NRF618	820 100 1	x		6/28/67	2.68	PWR fuel rods
84	48	NRF618	800 50 1	x		8/16/68	10.33	PWR fuel rods
85	51	NRF618	840 10 2		x	11/6/69		Control rod drives
86	51	NRF618	830 5 1		x	11/17/69		Control rod drive
87	51	NRF618	800 5 1		x	11/25/69		Control rod drive
88*	CF608U NKN	OFFATI	800 100	x		2/28/69	0.36	RWMIS says fuel rods
89*	CF608U NKN				x	2/28/69		RWMIS says fuel rods, but it is an incomplete record
90	54	PBF620	800 3000 45	x		10/23/70	0.30	Inconsistency on U mass on manifest
91	19	PERAII	800 999999999 (100000 10000)***		x	11/11/60		Dummy fuel and control elements
92	44	PER601	800 1100 250	x		2/8/67	1.6	UO2 on filter (probably from experiment)
93	43	PER601	800 1500 500	x		3/29/67	1.5	UO2 on filter (probably from experiment)
94	45	PER601	800 1300 45	x		6/15/67	1.5	UO2 on filter (probably from experiment)
95	49	PER601	800 3000 50	x		1/15/69	0.13	Powdered UO2 from experiment
96	49	PER601	800 250 50	x		2/18/69	0.13	Powdered UO2 from experiment
97	49	PER601	810 100 5	x		3/14/69	0.3	Powdered UO2 from experiment

ITEM	TRENCH	GENERATOR	SM #	SNF	NON SNF	PLACEMENT DATE	URANIUM MASS (Kg)	COMMENTS
98	50	PER601	800 3 0	x		9/25/69	0.83	Pieces of fuel rods
99*	49	TAN601	810 150 5	x		6/10/69	14.0	RWMIS says fuel rods
100	26	TAN607	800 40000003100000		x	7/6/62		"Scrap metal, fuel elements"?, 4000 R/hr
101	43	TAN633	800 100 10	x		11/16/66	0.045**	Incomplete information on manifest
102*	UNKN UNKN	TAN633	800 450 50		x	8/30/68		RWMIS says fuel rods no uranium
103	49	TAN633	800 2000 180		x	3/11/69		Control rods
104	49	TAN633	810 200 20		x	5/20/69		Control rod parts
105	49	TAN633	850 800 50		x	5/28/69		Control rod parts
106	50	TAN633	820 50000 250		x	8/5/69		Filter media and cladding
107	17	TRA642	800 6000000 667000		x	2/10/60		Fuel element rod ends
108	17	TRA642	800 110000 13000		x	2/11/60		End boxes
109	17	TRA642	810 2400R 250R (2400000 250000)		x	2/11/60		End boxes
110	17	TRA642	820 3000R 350R (3000000 350000)		x	2/11/60		Unknown - no U
						TOTAL:	124.6395	

1 NON-SNF per evaluation of material characteristics

* No shipping manifest is available, evaluation made from RWMIS printout

** Conflicting U mass information on manifest and RWMIS printout. Mass listed is worst case.

*** Numbers in parentheses are shipment numbers from the RWMIS printout, which are different than the associated shipping manifest number.

13. NR:IBO-98/034—ADDITIONAL INFORMATION ON PAST AND PROJECTED FUTURE RADIOISOTOPE INVENTORY FROM THE NAVAL REACTORS FACILITY AND COMMENTS ON THE ASSUMPTIONS USED IN THE RADIOACTIVE WASTE MANAGEMENT COMPLEX PERFORMANCE ASSESSMENT

Department of Energy

Pittsburgh Naval Reactors Office
Idaho Branch Office
P.O. Box 2469
Idaho Falls, Idaho 83403-2469

NR:IBO-98/034

February 27, 1998

J. T. Case, Manager
Waste management Programs
Idaho Operations Office, USDOE

SUBJECT: ADDITIONAL INFORMATION ON PAST AND PROJECTED FUTURE RADIOISOTOPE INVENTORY FROM THE NAVAL REACTORS FACILITY AND COMMENTS ON THE ASSUMPTIONS USED IN THE RADIOACTIVE WASTE MANAGEMENT COMPLEX PERFORMANCE ASSESSMENT

Reference (a) J. T. Case letter to T. M. Bradley, OPE-RWMC 96-068 dated December 6, 1996
(b) NR/IBO letter NR:IBO-97/175 dated October 6, 1997
(c) NR/IBO letter NR:IBO-97/193 dated October 21, 1997

In 1994 DOE began preparing a Performance Assessment for the INEEL Radioactive Waste Management Complex (RWMC). The Performance Assessment was to analyze the expected dose to the public from RWMC operations from 1984 until the assumed closure of the burial ground in 2020. A Composite Analysis is under preparation to assess the dose to the public from past and future operations of the burial ground at RWMC, along with any associated effects from other INEEL facilities. The Performance Assessment was completed and approved by DOE-HQ in 1996. The Performance Assessment supported a threshold of 180 curies of Carbon-14 as the maximum allowed to be disposed of from 1984 until closure. To ensure meeting this limit, the Radioactive Waste Acceptance Criteria for RWMC was changed to allow a maximum of two curies-per-year of Carbon-14 in activated metal to be disposed of each year. The Performance Assessment has some very conservative assumptions such as assuming corrosion rates for all disposed materials are the same as the worst corrosion rate (i.e., taking insufficient credit for the extended longevity of zircaloy and nickel based alloys). A more precise analysis is being done in the Composite Analysis.

In support of the Composite Analysis, DOE-ID requested, in reference (a), historical information and future projections on the radionuclide content of waste from the Naval Reactors Facility for burial at the Radioactive Waste Management Complex (RWMC). Until the 1990s, detailed information on isotope content was not required by RWMC as a condition for disposal, and therefore only cobalt-60 was reported by NRF for much of this period. To perform the composite analysis additional information is needed by RWMC. In references (b) and (c), NR-IBO provided information on the content of carbon-14 and other long-lived isotopes in past waste sent from NRF. In reference (c), NR-IBO stated that additional work was being performed to refine the estimates of trace radionuclides and to provide information on future projections. NR-IBO also committed to provide comments on the conservative assumptions used in the Performance Assessment so that the overly conservative assumptions are not carried over into the Composite Analysis. This letter provides the requested radionuclide specific information and comments on the Performance Assessment.

The curies of specific requested isotopes are provided in the following table for both past shipments and projected future waste generation. The date of the cutoff between past and projected future waste generation is October 1, 1997. The future projection overestimates what will actually be shipped because the projection includes some material that will be above the concentration limits for RWMC acceptance. We plan to continue our ongoing work with you to allow us to determine the optimum disposal path for this material. The material above RWMC acceptance criteria was included in the future projection because we are still evaluating how much material will exceed RWMC acceptance criteria from future core types for which we have no past experience. When this evaluation is completed in a few months, I will revise the future projection downward as appropriate.

Nuclide	To RWMC 1955-10/1/97	To RWMC 1984-10/1/97	Future 10/1/97-2020
C-14 in other than activated metal	4.1E+1	6.5E+0	1.2E+1
C-14 in metal	9.8E+1	3.7E+1	1.2E+2
I-129	9.7E-5	3.4E-5	5.2E-6
Tc-99	5.2E-2	1.4E-2	2.0E-2
Ni-59	2.9E+3	1.7E+3	8.3E+3
Ni-63	3.4E+5	2.2E+5	1.0E+6
K-40	4.7E-6	8.0E-7	8.3E-6
Nb-94	1.3E+1	3.7E+0	2.2E+1

The precursor concentrations used to calculate some of the radionuclide inventories listed in the above table have been updated since reference (c) was issued. Thus, some of the past inventories for radionuclides other than C-14 have changed. These changes are not significant, however, since all radionuclides other than C-14 are a very small fraction of the amounts that might be of concern based on the performance assessment.

The calculation of curie contents in the above table should be considered as a best estimate. The concentrations of precursor elements used in activation calculations for activated metals were the average of the available information from actual testing, vendor certifications, and literature sources, and thus are best estimate concentrations. The neutron fluences used in the activation calculations are best estimate values, and thus the overall calculation is a best estimate.

The only isotope for which the projected future inventory approaches or exceeds the inventory limits of the performance assessment is C-14 in both activated metal and waste other than activated metal. The derivation of the C-14 inventory limits in the RWMC-prepared Performance Assessment was extremely conservative. The resulting RWMC C-14 inventory limits were more than an order of magnitude lower than those calculated by Savannah River and Hanford for the burial grounds at those sites. I have attached a detailed discussion of some of the more conservative assumptions. Use of more reasonable but still justifiable assumptions in the composite analysis will result in much higher allowable C-14 inventory limits that will support the waste shipments projected from NRF. I would like to ensure these more reasonable assumptions will be used in the composite analysis. Please keep me informed of the progress so that we have a chance to comment on it as it is developed.

If there are any questions, please contact me at 533-5317 or Mike Kuprenas at 533-5066.

T. M. Bradley, Manager
Naval Reactors Idaho Branch Office

cc: J. J. Mangeno, NR-08R
T. H. Beckett, NR-08U
C. H. Schmitt, NR-08B
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Attachment to
NR:IBO-98/034 dated
February 27, 1998

Evaluation of Conservative Assumptions in the RWMC Performance Assessment

1. Corrosion Rates and Release from Activated Metal

In the RWMC Performance Assessment, activated metal corrosion release was considered to be that which stainless steel structural material would experience in warm tropical seawater. This is the worst possible corrosion environment for stainless steel and is not representative of long term RWMC conditions. The following table provides a range of stainless steel corrosion data from a variety of environments.

Corrosion Rate (in/yr)	Corrosion Environment	Reference
3.0E-4	Tropical seawater	(a)
6.7E-5	Damp coastal sand with high chlorides	(b)
2.1E-5	Maximum observed rate in NBS soil tests	(c)
1.3E-5	Poorly aerated soil with high chlorides	(c)
9.8E-9	Hanford soil with low chlorides	(d)

The performance assessment used the worst case corrosion numbers for stainless steel, the corrosion rate for immersion in tropical seawater. The RWMC clearly is not a tropical seawater environment. RWMC should have a lesser corrosion rate because the waste would not be continuously immersed in water, the average temperature would be significantly lower, and high chloride conditions should not be present over the long term. (Even though high chloride conditions are present in some areas at RWMC from past road salt applications, this condition should not last for the thousands of years covered by the performance assessment analysis.) One of the mid range corrosion rates from the above table, such as the maximum rate observed in NBS soil testing, would appear to be more suitable for RWMC. This would be consistent with the Savannah River Site performance assessment, which assumed a corrosion rate of 2E-5 inch/yr (reference (e)).

2. Special case of Corrosion of Zircaloy and Hafnium

Much of the C-14 in activated metal generated at NRF is in activated zircaloy and hafnium. These metals are extremely corrosion resistant and will not contribute significantly to the C-14 source term during the period while stainless steel and inconel are corroding. The RWMC composite analysis should either exclude zircaloy and hafnium from the calculation or use a much lower corrosion rate. The Savannah River Site performance assessment uses a corrosion rate of 2E-6 inch/yr for zircaloy (reference (e)).

In order to be able to take into account the radioactivity in highly corrosion resistant activated metals, the following information is provided. (Some of the following numbers may not match the overall totals in the cover letter due to the effects of rounding.)

Radioactivity by Material Type from 1955 to 1983

Nuclide	Zircaloy	Hafnium	Stainless Or Inconel
C-14	2.4E+1	2..5E+0	3.3E+1
I-129	3.6E-6	5.9E-5	7.6E-8
Tc-99	2.0E-3	1.9E-2	1.8E-2
Ni-59	1.3E+1	2.9E-2	1.2E+3
Ni-63	1.7E+3	4.9E+0	1.2E+5
K-40	3.8E-6	3.6E-8	1.3E-7
Nb-94	1.3E-1	1.0E+0	8.1E+1

Radioactivity by Material Type from 1984 to 10/1/97

Nuclide	Zircaloy	Hafnium	Stainless Or Inconel
C-14	6.1E+0	1.5E+0	2.9E+1
I-129	8.1E-7	3.3E-5	1.0E-7
Tc-99	4.4E-4	1.0E-2	3.6E-3
Ni-59	5.8E-1	1.0E-2	1.7E+3
Ni-63	7.6E+1	9.4E-2	2.2E+5
K-40	6.9E-7	1.2E-8	9.1E-8
Nb-94	2.4E-2	3.7E-1	3.3E+0

Radioactivity by Material Type from 10/1/97 to 2020

Nuclide	Zircaloy	Hafnium*	Stainless Or Inconel
C-14	7.6E+1	0.0	4.3E+1
I-129	4.8E-6	0.0	4.1E-7
Tc-99	5.7E-3	0.0	1.4E-2
Ni-59	6.2E+0	0.0	8.3E+3
Ni-63	8.1E+2	0.0	1.0E+6
K-40	7.8E-6	0.0	5.3E-7
Nb-94	2.0E-1	0.0	2.2E+1

*Current practice is to retain control rods with the fuel modules. As a result, no future disposal of irradiated hafnium is planned.

3. Distribution Coefficients

The distribution coefficient of C-14 in the RWMC performance assessment is conservatively assumed to be zero, which means that the C-14 is assumed to move through the ground with the velocity of infiltrating water. The RWMC performance assessment includes some discussion of site specific research indicating that a distribution coefficient from 4 to 7 mL/g might be appropriate for RWMC. A distribution coefficient of 5 mL/g would reduce the C-14 dose by an order of magnitude.

4. Volume to Surface Area Ratio

In a discussion with NR-IBO (Kuprenas) on October 27, 1997, LMITCO (Logan) requested information on the average thickness of Naval activated metal components. The thickness of an activated metal component determines the period of time over which the radioactivity in that component can be released by corrosion. The RWMC performance assessment used a volume to surface area ratio (equivalent to half of the thickness) of 0.72 inch. The Naval activated metal components sent to RWMC in the past and projected in the future have a range of thicknesses. Some are thicker and some are thinner than assumed in the performance assessment. While a calculation of the curie-weighted average thickness has not been performed, most of the components are thinner than assumed in the performance assessment. The 0.72 inch volume-to-surface area ratio appears to be roughly 15 percent higher than the Naval component average. This is a minor nonconservative factor in the overall performance assessment methodology.

5. Overall Conservative Result

Due to the very conservative corrosion rate and distribution coefficient assumptions, the activated metal C-14 inventory limit calculated in the RWMC performance assessment is much lower than those calculated in the Savannah River and Hanford performance assessments. The Savannah River performance assessment has an activated metal C-14 limit of 180,000 curies for Naval Reactors components alone (reference (e)). The Hanford performance assessment has a limit of 3040 curies for C-14 in activated waste (reference (f)).

References: (a) NUREG/CR-4370, Vol. 1, dated January 1986, "Update of Part 61 Impacts Analysis Methodology"
(b) NBSIR 81-2228, dated February 1981, "The Corrosion Behavior of Selected Stainless Steels in Soil Environments"
(c) NBS Circular 579, dated April 1957, "Underground Corrosion"
(d) TR-2001-SHR, dated December 1993, "Corrosion Behavior of HY-80 Steel, Type 304 Stainless Steel, and Inconel Alloy 600 at 218E-12B Burial Ground, Hanford, WA"
(e) Savannah River Site Radiological Performance Assessment for the E-Area Vaults Disposal Facility (WSRC-RP-94-218); Revision to Appendix L Naval Reactor Waste Disposal, June 27, 1996
(f) Hanford Performance Assessment for the Disposal of Low-Level Waste in the 200 West Area Burial Grounds (WHC-EP-0645); November 1994 (Draft)

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RECORD NOTE:

Subj: **ADDITIONAL INFORMATION ON PAST AND PROJECTED FUTURE RADIOISOTOPE INVENTORY FROM THE NAVAL REACTORS FACILITY AND COMMENTS ON THE ASSUMPTIONS USED IN THE RADIOACTIVE WASTE MANAGEMENT COMPLEX PERFORMANCE ASSESSMENT**

1. **Brief:** This letter, to be signed by Bradley (IBO), provides additional information that DOE-ID needs for its contractors to complete an environmental evaluation and derive radionuclide-specific inventory limits for the burial ground at the INEEL Radioactive Waste Management Complex (RWMC).

2. **Summary:** In September 1997, DOE-ID expressed concerns about the inventory of carbon-14 in past waste shipments. Bettis (Detrick and Connors) led a Bettis/KAPL task force which evaluated past and future waste shipment curie contents. Data on past shipments was provided to DOE-ID in October 1997, and NRF waste shipments were allowed to continue within the 2 curie/yr C-14 limit that had been in place since early 1997. This letter adds the future projections out to 2020 and provides information on how the burial ground environmental analysis can be made less conservative and more realistic. Since past NRF C-14 waste shipments have averaged about 8 curies of C-14 per year, higher C-14 limits are needed. This draft letter is based on work by the Detrick/Connors task force and a review by Steele (Mangeno) and Kuprenas (IBO). Detrick (Bettis) has reviewed a draft of this letter and concurs with it.

STEELE(MANGENO):steele 2/18/98 X28713

14. NR:IBO-97/193—ADDITIONAL INFORMATION ON ISOTOPES SHIPPED FROM THE NAVAL REACTORS FACILITY TO THE RADIOACTIVE WASTE MANAGEMENT COMPLEX

Department of Energy

Pittsburgh Naval Reactors Office
Idaho Branch Office
P.O. Box 2469
Idaho Falls, Idaho 83403-2469

NR:IBO-97/193

October 21, 1997

J. T. Case, Manager
Waste Management Programs
Idaho Operations Office, USDOE

SUBJECT: ADDITIONAL INFORMATION ON ISOTOPES SHIPPED FROM THE NAVAL REACTORS FACILITY TO THE RADIOACTIVE WASTE MANAGEMENT COMPLEX

Reference: (a) J. T. Case letter to T. M. Bradley, OPE-RWMC 96-068 dated December 6, 1996
(b) NR/IBO letter NR:IBO-97/175 dated October 6, 1997

In reference (a), DOE-ID requested historical information on the radionuclide content of waste sent from the Naval Reactors Facility for burial at the Radioactive Waste Management Complex. This information is needed now to perform a composite analysis of the dose to the public from past and future operations of the burial ground. Until the 1990s, detailed information on isotope content was not required by RWMC as a condition for disposal, and therefore only cobalt-60 was reported for much of this period. To perform the composite analysis, additional information is needed. In reference (b), NR-IBO provided information on the carbon-14 content of activated metal waste sent from NRF, and committed to provide information on additional isotopes. This letter provides the additional information. The curies of specific requested isotopes are as follows:

Nuclide	To RWMC 1955-1997	To RWMC 1984-1997
C-14 in other than activated metal	*	6.5E+0
I-129	4.0E-5	2.9E-5
Tc-99	3.1E-2	1.0E-2
Ni-59	2.7E+3	1.7E+3
Ni-63	3.5E+5	2.2E+5
K-40	3.0E-5	2.2E-5
Nb-94	1.3E+1	4.1E+0

* The C-14 in other than activated metal prior to 1984 is still being researched.

For the trace radionuclides other than C-14, the above information should be considered as conservative upper bound estimates. For some activated metals, actual measurements of the concentration of some precursor elements were not available. In such cases, conservatively high precursor concentrations were used. Actual precursor element concentrations are being measured for various samples, and the above reported quantities may be revised downward. However, for the trace radionuclides other than C-14, the above totals are at least a factor of 100 below the total inventory limits identified in the RWMC Performance Assessment.

In reference (b), IBO stated that detailed comments and information on some of the conservative assumptions in the Performance Assessment would be provided by October 17, 1997. Our review is still underway, and I expect to provide this information to you by October 31, 1997.

If there are any questions, please contact me at 533-5317 or Mike Kuprenas at 533-5066.

T. M. Bradley, Manager
Naval Reactors Idaho Branch Office

cc: J. J. Mangeno, NR-08R
R. A. Guida, NR-08U
C. H. Schmitt, NR-08B
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J. M. Wilcynski, DOE-ID

15. NR:IBO-97/175—INFORMATION ON THE CARBON-14 CONTENT OF PAST ACTIVATED METAL SHIPMENTS FROM THE NAVAL REACTORS FACILITY TO THE RADIOACTIVE WASTE MANAGEMENT COMPLEX

Department of Energy

Pittsburgh Naval Reactors Office
Idaho Branch Office
P.O. Box 2469
Idaho Falls, Idaho 83403-2469

NR:IBO-97/175

October 6, 1997

J. T. Case, Manager
Waste Management Programs
Idaho Operations Office, USDOE

SUBJECT: INFORMATION ON THE CARBON-14 CONTENT OF PAST ACTIVATED METAL SHIPMENTS FROM THE NAVAL REACTORS FACILITY TO THE RADIOACTIVE WASTE MANAGEMENT COMPLEX

Reference: (a) J. T. Case letter to T. M. Bradley, OPE-RWMC 96-068 dated December 6, 1996
(b) NR/IBO letter NR:IBO-97/134 dated August 20, 1997

In 1994 DOE began preparing a Performance Assessment (PA) for the INEEL Radioactive Waste Management Complex (RWMC). The PA was to analyze the expected dose to the public from RWMC operations from 1984 until the assumed closure of the burial ground in 2020. An additional assessment, the Composite Analysis (CA), is under preparation to assess the dose to the public from past and future operations of the burial ground at RWMC, along with any associated effects from other INEEL facilities. The PA was completed and approved by DOE-HQ in 1996. The PA supported a threshold of 180 curies of Carbon-14 as the maximum allowed to be disposed of from 1984 until closure. To ensure meeting this limit, the Radioactive Waste Acceptance Criteria for RWMC was changed to allow a maximum of two curies per year of Carbon-14 in activated metal to be disposed of each year. The PA has some very conservative assumptions such as assuming corrosion rates for all disposed materials are the same as the worst corrosion rate (i.e., taking insufficient credit for the extended longevity of zircaloy and nickel based alloys). A more precise analysis is being done in the CA.

In reference (a) DOE-Idaho requested historical information on the radionuclide content of waste sent from the Naval Reactors Facility (NRF) for burial at RWMC. This information is needed now to perform the CA, and to confirm the information on post-1984 disposals assumed in the PA. Until the 1990s, detailed radionuclide information was not required by RWMC as a condition for disposal, and only cobalt-60 was reported for much of this period. Thus, Naval Reactors originally provided the requested information in reference (b) as a table relating the year-by-year ratios of the requested isotopes (e.g., C-14, Tc-99, I-129, etc.) to the curies of Cobalt-60. Due to a misunderstanding by NRF about how this data was going to be applied, an incorrect value of approximately 7000 curies of C-14 was calculated by RWMC. This value was significantly higher than the 180 curies determined to be the threshold in the PA that provides the authorization basis for the RWMC. Shortly after being informed of this misunderstanding, IBO informed RWMC that the total C-14 radioactivity in activated metal had been calculated to be less than 200 curies. However, IBO indicated that more precise radionuclide information would be provided at a later date.

Naval Reactors has recalculated the amount of C-14 in activated metal shipments. Additional efforts were made to ensure greater precision in the calculation. Some of the changes included using actual measurements of the concentration of nitrogen in the materials (nitrogen is the

precursor to C-14) and better estimates of actual end of life core fluences. These calculations show that from 1955 until 1997, NRF shipped approximately 98 curies of C-14 in activated metal to RWMC. Of these 98 curies, approximately 34 curies were in extremely corrosion resistant zircaloy and hafnium and approximately 64 curies were in very corrosion resistant inconels and stainless steels. Approximately 37 curies were shipped from January 1984 until today. Of these 37 curies, approximately 8 curies were in extremely corrosion resistant zircaloy and hafnium and approximately 29 curies were in very corrosion resistant inconels and stainless steels. Additional information on historic shipment of other isotopes of concern will be provided by October 17, 1997, information on the C-14 content in material other than activated metal will be provided by October 17, 1997, and information on future projections of the requested isotopes will be provided by October 31, 1997. We also intend to provide detailed comments and information on some of the conservative assumptions in the PA by October 17, 1997, and to participate in the review of the CA.

If there any questions, please contact me at 533-5317 or Mike Kuprenas at 533-5066.

for T. M. Bradley, Manager
Naval Reactors Idaho Branch Office

cc: J. J. Mangeno, NR-08R
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